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ENGINEERING FLIGHT TEST OF THE UH-1C HELICOPTER EQUIPPED WITH THE XM-30 WEAPON SYSTEM

ARMY PRELIMINARY EVALUATION

FINAL REPORT

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PROJECT PILOT

NOVEMBER 1967

U. S. ARMY AVIATION TEST ACTIVITY
EDWARDS AIR FORCE BASE, CALIFORNIA 93523

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ABSTRACT

The Army Preliminary Evaluation of the UH-1C/XM-30 weapon system was conducted by the U. S. Army Aviation Test Activity at Edwards Air Force Base and Fort Irwin, California from 11 July 1967 through 26 July 1967. The degradation in level flight performance attributed to the weapon installation was defined and no objectionable flying qualities were encountered during firing or non-firing tests. The armed mission capability of the helicopter was degraded by high levels of stress, vibration, blast, and noise during firing and restrictive limitations were imposed by gun malfunctions and system gross weight. The reliability of the weapon system was poor and should be improved prior to further Army testing.

FOREWORD

The U. S. Army Aviation Materiel Command assigned responsibility for preparing the test plan, conducting the test, and submitting the final report to the U. S. Army Aviation Test Activity. Bell Helicopter Company provided helicopter and instrumentation maintenance and limited data reduction assistance. Weapon system maintenance was performed by the Aeronutronic Division of Philco-Ford and the Missile and Armament Department of General Electric.

INTRODUCTION

BACKGROUND

1. Contractor firing and non-firing flight tests of the UH-1C/XM-30 were conducted at the Bell facility at Ft Worth, Texas and at Ft Hood, Texas, during the period 12 September 1966 through 11 November 1966. After modifications indicated by test results were incorporated, non-firing tests resumed in May 1967 culminating in the move to Edwards AFB, California on 9 June 1967 for the contractor firing phase (reference b) and the Army Preliminary Evaluation (APE). Testing on reliability, accuracy, and ballistics has been in progress at the General Electric facility at Burlington, Vermont, since February 1967. The Engineering/Service Test (ET/ST), scheduled to commence in July 1967, was postponed until June 1968 pending further weapon system and ammunition development.

2. Authority for the U. S. Army Aviation Test Activity (USAAVNTA) participation in the test program was provided by the test directive issued by the U. S. Army Aviation Materiel Command (USAAVCOM) on 6 June 1967 (reference a). It provided for monitorship of the contractor's firing test program and for the conduct of the APE.

TEST OBJECTIVES

3. The objective of the APE was to furnish the procuring activity (USAAVCOM) with preliminary results derived from the USAAVNTA participation in the Airworthiness Qualification Program of the UH-1C/XM-30 prior to the conduct of the ET/ST. Specific objectives were:

a. To provide quantitative flight test data to serve as a basis for an estimate of the degree to which the helicopter is suitable for its intended mission.

b. To assist in determining if the contractor's proposed flight envelope should be used by Army pilots for future service, logistical, or operational tests.

c. To define any total weapon system deficiencies to allow early correction.

d. To provide a basis for evaluation of changes incorporated to correct helicopter deficiencies.

e. To provide preliminary helicopter performance data for service testing.

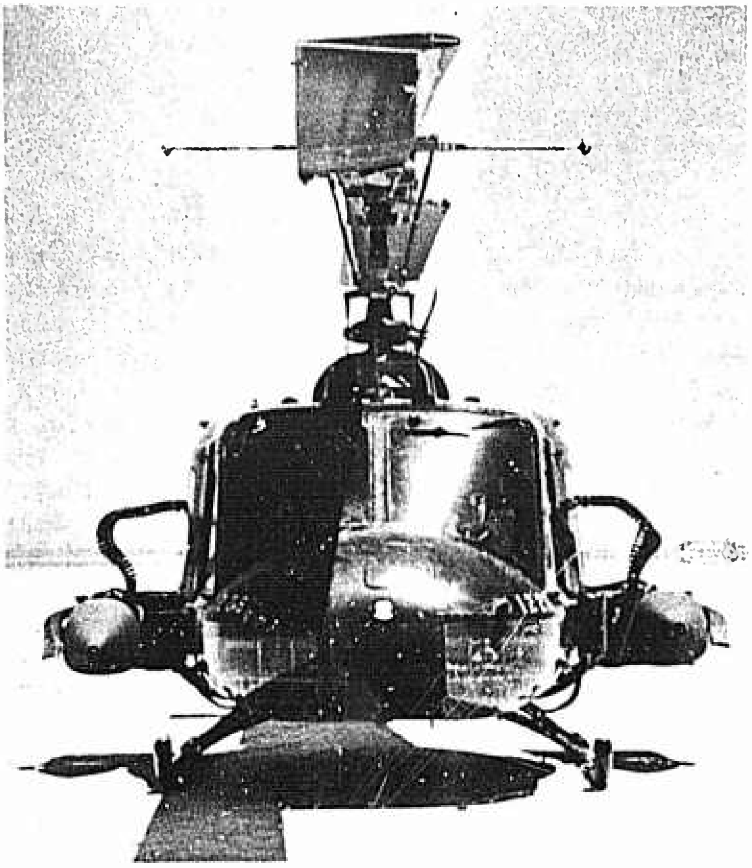


Photo 1 - UH-1C Equipped with XM-30 Weapon System

DESCRIPTION OF AIRCRAFT AND WEAPON SYSTEM

4. A production UH-1C helicopter, serial number 64-14102, was utilized to conduct the firing and non-firing tests. The following nonstandard modifications were incorporated in the test helicopter for the XM-30 installation:

a. Redesigned aft doors and windows to replace the standard sliding doors of UH-1 series helicopters.

b. Reinforced plexiglass in the pilot's and copilot's doors.

c. Reinforced leading edge of synchronized elevator.

d. Blast deflector strip installation along the outside, aft frame of the pilot's and copilot's doors.

Additional information on the helicopter may be found in the Operator's Manual (reference d) and Bell Report No. 204-100-147 (reference f).

5. The 30 mm automatic (XM-140) guns were mounted in electrically operated turrets on each side of the helicopter (photo 1). A design capability for 8 degrees elevation, 45 degrees depression, and 60 degrees outboard azimuth was intended; however, limitations on these turret displacements are discussed in paragraphs 39 and 43. The 30 mm gun was designed to fire 425 shots per minute (spm) and ammunition box storage of 600 rounds per gun is provided. Additional details are found in appendix III.

SCOPE OF TESTS

6. The UH-1C/XM-30 was evaluated in order to acquire limited performance data and to assess the flying qualities of the helicopter in both the firing and non-firing modes. The flight envelope and operating limitations remained similar to the armed UH-1C helicopter with the exception of the aft center of gravity (C.G.) limit which was moved one inch forward (references c and d). The tests conducted and limits of the test are found in the test plan (reference g).

7. Testing was conducted at Edwards AFB and Ft Irwin, California, from 11 July 1967 through 26 July 1967. Thirty seven test flights were conducted with a total of 20.1 data flight hours accumulated (31.7 flying hours in the program). A total of 850 rounds of 30 mm inert ammunition was expended during the 6 days on the firing range.

8. The performance and flying qualities of the UH-1C/XM-30, where applicable, were compared to the unarmed UH-1C (reference e) and to the data acquired during previous contractor testing (reference f). Pilot Opinion Rating (POR) was used to augment qualitative comments where appropriate. An index to these ratings is listed in appendix V.

METHODS OF TEST

9. Standard USAAVNTA test methods were utilized to acquire data for analysis and evaluation in order to determine the effect of the XM-30 installation on performance and flying qualities of the UH-1C helicopter. With the exception of engine output shaft torque, performance instrumentation was limited to calibrated instruments installed in the cockpit. A detailed list and description of the test instrumentation is found in appendix IV and the contractor's flight test specification (reference h).

CHRONOLOGY

10. The chronology of the test was as follows:

a. Test Directive Issued .... 6 June 1967

b. Test Directive Revision ....23 June 1967

c. Contractor's Test Completed ....10 July 1967

d. First Flight, Army Preliminary Evaluation ....11 July 1967

e. Last Flight, Army Preliminary Evaluation ....26 July 1967

RESULTS AND DISCUSSION

GENERAL

11. Within the limited scope of the APE, the installation of the XM-30 weapon system on the UH-1C helicopter significantly increased level flight power required and decreased level flight airspeed capability. Although control position requirements changed and helicopter sensitivity and response were altered, the flying qualities of the UH-1C/XM-30 were not objectionable to the pilot in either the firing or non-firing modes.

AIRSPEED CALIBRATION

12. A production airspeed system calibration was conducted to validate contractor data from previous tests. The calibration was performed in level flight and a ground speed course was utilized. The test conditions and results are presented in figure 1, appendix I.

13. The position error was found to be the same as that determined from previous data and varied from 0 knots (kt) at 50 knots indicated airspeed (KIAS) to a maximum of +4 kt at 120 KIAS. The error was the same for the operational range of rotor speeds and was not influenced by ground proximity or open cockpit windows. The calibration did not include determination of any variation with gun position or aircraft gross weight. The correlation with the contractor's level flight calibration was considered sufficient justification to accept the previous results determined in climb and autoratation. The level flight position error was also in close agreement with the unarmed UH-1C errors listed in the Operator's Manual (reference d).

WEIGHT AND BALANCE

14. Upon completion of contractor testing, a USAAVNTA weight and balance was performed to verify gross weight (G.W.) and C.G. calculation prior to the APE. The results indicated that the helicopter was 96 lb heavier and the C.G. was 0.8 in. farther forward than previously calculated for the basic test weight without fuel, ballast, ammunition or crew. The USAAVNTA results were used for all loadings during the APE.

15. Based on contractor weight and balance figures of 19 April 1966, the UH-1C/XM-30 mission G.W. was 9736 lb including full fuel, 1200 rounds of ammunition, a crew of 2, and 166 lb of supplemental combat equipment. Without considering power limitations, 236 lb of fuel or ammunition must be off-loaded to lower the G.W. to the maximum allowable weight of 9500 lb. For operations in Southeast Asia, 1/2

the full ammunition load (at 1.08 lb per round) and 1/2 to 3/4 the full fuel load would be more realistic as indicated in table 1 (calculations based on UH-1C Phase D date, reference e).

Table 1. Hover Limitations.

Pressure Altitude ft	Temperature deg F	Skid Height ft	Maximum G.W. lb
S. L.	95	2	8850
2550	95	2	8400

The resulting loss of range and endurance coupled with a 50 percent reduction in firing time per gun (reduced to 45 sec at 400 shots per minute) would seriously degrade the armed mission capability of the helicopter.

PERFORMANCE

Level Flight Performance

16. The aircraft configuration and the existing ambient conditions severely limited the scope of the tests. Testing was conducted at gross weights of 8000 and 8800 pounds, density altitudes (H_D) of 5000 and 10,000 feet, and rotor speeds of 324 and 314 rpm. Since a calibrated engine was not installed, the drag contribution of the XM-30 system was determined by conducting power required tests at similar conditions for both the clean (unarmed) and armed configurations. Gun positions were also varied to determine changes in drag characteristics. The test results are presented in figures 2 through 13, appendix I.

17. The range summary data presented in figures 4 and 5 were calculated from the test power required data and the engine model specification fuel flow data in figure 16. The XM-30 installation decreased the specific range 15 percent at best cruise speed, a gross weight of 8500 pounds, and 5000 ft altitude (standard day). The airspeed for the best range was decreased 15 knots true airspeed (KTAS).

18. Maximum airspeed was limited by power available for all conditions tested and the speed capability at normal rated power is presented in figure 6. The 5000 ft, standard day results were 93 KTAS and 101 KTAS for 9500 and 8500 pounds respectively. This represented an average reduction of 17 kt compared to the clean configuration.

19. Power required test results are presented in figures 7 through 13. The armed configuration data generally agreed with results from previous contractor tests although the curve characteristics were somewhat different. There was a tendency to indicate higher power required at airspeeds above 90 kt and the opposite trend was apparent at lower airspeeds. The clean configuration data from previous contractor tests and previous and current USAAVNTA tests indicated a variation of 25 shaft horsepower (shp). There was no particular pattern evident in the variations.

20. The XM-30 installation resulted in a significant increase in power required and decrease in airspeed. The increased drag became more pronounced at higher airspeeds and thrust coefficients (C_T). Two comparisons between the performance of the clean and armed configurations for similar gross weights, 5000 ft H_D, and 324 rotor rpm are presented in table 2.

Table 2. Level Flight Performance Comparison.

Configuration	G.W. lb	$C_T \times 10^4$	C.G. Station	Power Required at 100 KTAS shp	Maximum Airspeed Capability * KTAS
Unarmed	8870	51.11	130.5	677	127
Armed	8760	50.50	130.6	828	106
Unarmed	8050	47.42	130.5	657	127
Armed	7980	46.00	130.1	795	110

* Based on take off power available, 5000 ft, standard day.

The XM-30 installation did not significantly reduce the maximum endurance of the helicopter (less than 5 percent).

21. The basic level flight performance was conducted with the guns in the stowed position and at a mid C.G. location. The effects of gun position and C.G. variation are illustrated in figure 13. The power required increased as the guns were depressed and decreased with gun elevation. The forward C.G. condition was more sensitive to gun depression while the effects were similar for both depression and elevation at an aft C.G. A maximum airspeed loss of 16 kt occurred at the forward C.G. condition when the guns were lowered from

7.5 degrees up to 42.5 degrees down. Deflecting the guns from zero to 60 degrees left azimuth at 0 degrees elevation resulted in an 8 kt airspeed loss. The airspeed changes with gun position should become larger at increased trim airspeeds.

STABILITY AND CONTROL

Static Trim Stability

22. The level flight static trim data were recorded during the power required tests. All controls were in the positions required to trim the helicopter in stabilized level flight and the results are presented in figures 17 through 21. The control requirements while hovering in winds were simulated by sideward and rearward flight utilizing a calibrated ground vehicle for pace. The surface wind averaged 4 kt and there were no significant external disturbances to the aircraft. This data is shown in figures 22 and 23. Control position changes with turret movements are presented in figure 24.

23. The XM-30 installation reduced the forward stick requirements by 5 percent (0.65 in) at a rotor speed of 324 rpm and a G.W. of 8000 pounds. The magnitude of the stick position change was slightly less with increased G.W. The trend exhibited was for a decreasing control position differential with higher airspeeds.

24. For the armed configuration, the longitudinal stick position moved aft 5 percent at an airspeed of 80 knots calibrated airspeed (KCAS) as altitude was increased from 5000 to 10,000 ft. A similar stick position change was introduced by reducing rotor speed from 324 to 314 rpm. Control required characteristics were not appreciably different from those recorded with an unarmed UH-1C helicopter (reference e) and more than 10 percent control margin was available at translational speeds of 35 kt sideward and rearward ((POR) 3.0).

Static Longitudinal Collective Fixed Stability

25. The static longitudinal stability tests were conducted at different trim airspeeds, rotor speeds of 324 and 314 rpm, turrets in the stowed position, and a density altitude near 5000 feet. Center of gravity locations were from stations 128.8 to 134.0. Limited tests were conducted to evaluate stability changes as a result of rotor speed variations. Test results are presented in figures 25 through 31, appendix I.

26. With the XM-30 installed, static longitudinal stability about the trim point was positive (forward stick required to increase airspeed) for all conditions tested. There were no significant discontinuities in the longitudinal stick motion and there were no ab-

normal lateral or directional control requirements. The stability became less positive as the center of gravity location was moved aft. A slight increase in forward longitudinal stick required was noted with reduction in rotor rpm from 324 to 314; however, the degree of static longitudinal stability remained essentially the same. Static longitudianl stability characteristics with the armament system installed were similar to those previously reported for an unarmed UH-1C (reference e).

Static Lateral - Directional Stability

27. The static lateral-directional stability test was limited to one test condition. The test data was obtained using ship service instrumentation and visual references. The results are presented in figure 32, appendix I.

28. Static directional stability was positive (left pedal required for right sideslip) for airspeeds of 55 and 90 KCAS and became more positive at the higher speed. The static directional stability of the UH-1C was relatively unchanged by the XM-30 installation and compared favorably to similar test conditions of reference e.

29. The effective dihedral, as indicated by lateral stick position with sideslip angle, was positive for sideslip angles $\pm 10^{\circ}$ from trim for both airspeeds. At larger sideslip angles there was a gradient reversal and the trend was for the effective dihedral to become neutral or slightly negative. This characteristic was more pronounced at the higher airspeed. The bank angle was in the proper direction and the increase was essentially linear with airspeed. The effective dihedral characteristics of the basic UH-1C helicopter were not adversely influenced by the XM-30 installation and there was no significant difference when compared to similar test conditions of reference e.

Dynamic Stability

30. The short period airframe response of the UH-1C/XM-30 to control pulse inputs was evaluated in the pitch, roll, and yaw axes. Time histories of response are presented in figures 33 through 35, appendix I, for a level flight trim speed of 91 KCAS, average G.W. of 8410 lb, aft C.G. location, and a density altitude of 5530 ft.

31. Pulse inputs were induced manually by the pilot without the use of control fixtures; however, the results indicate similar damping characteristics to those of the unarmed UH-1C with one exception. A longitudinal or directional pulse resulted in a lightly damped, long period, pitching oscillation. This oscillation was easily damped by small longitudinal control inputs and was not objectionable.

Controllability

32. The longitudinal control sensitivity (deg/sec^2) and response (deg/sec) were essentially the same as that of an unarmed UH-1C helicopter. As indicated by the dynamic stability results, the reduced damping resulted in a higher pitch rate and a greater attitude change per unit control displacement. These results are presented in figures 36 and 37.

33. The increased rolling moment of inertia reduced the lateral control power and resulted in a small reduction in control sensitivity. The maximum roll rates and the attitude reached at one second were also less than for an unarmed aircraft. Test results are presented in figures 38 and 39.

34. The most significant change in controllability was in the reduction in yaw acceleration and rate. The reduction with small pedal inputs was as much as 50 percent and 35 percent for sensitivity and response respectively and increased with the magnitude of pedal displacement. These characteristics are illustrated in figures 40 and 41.

FIRING

35. The limited firing tests were conducted to determine the effects of firing the 30 mm guns on the stability and control characteristics of the UH-1C helicopter. No safety-of-flight limitations were encountered from the handling qualities aspect; however, unacceptable conditions are discussed under vibration, blast, and noise and gun malfunctions (paragraphs 39 and 45 respectively). The maneuvers performed and test conditions flown are presented in table 3.

Table 3. XM-30 Firing Conditions. (Note 1)

Flight Condition	Airspeed KCAS	Turret (Note 2) Position
Hover in ground effect (IGE)	0	2
Hover IGE	0	3
Hover IGE	0	7 (Note 3)
Right Sideward Flight	30	3
Rearward Flight	40	2
Level Flight at Power Limit Airspeed (V_H)	94	7
Pedal Spray at .9 V_H	86	7
Dive at "Never Exceed" Airspeed (V_{NE})	131	7
Symmetrical pull up at V_{NE}	128	2-7-5 (Note 4)
Right rolling pull up at V_{NE}	126	7-6 (Note 4)
Left rolling pull up at V_{NE}	124	7-4 (Note 4)
Throttle chop at V_{NE}	126	5

NOTES TO TABLE 3. PRESENTED ON PAGE 12

Note 1: All firing runs were flown at 324 rotor rpm, average C.G. location at 128 in, gross weight ranging from 7800 lb to 8400 lb., and density altitudes (H_D) from 4400 ft to 7500 ft.

Note 2: Turret positions are indicated by the following diagram:

<table>
<tr><td>Up, Left 1</td><td rowspan="2">Up
2
7 (Stow)
5
Down</td><td>3 Up, Right</td></tr>
<tr><td>Down, Left 6</td><td>4 Down, Right</td></tr>
</table>

Both guns fire only in positions 2, 7, and 5.

Note 3: Right gun firing only; left gun turned off.

Note 4: Guns moving transiently.

36. During the firing, the most significant attitude changes occurred at a hover. A slight nose down pitch resulted from firing both guns elevated and asymmetric firing resulted in yaw in the direction of the firing gun (POR 3.0). These attitude changes were easily corrected by small control inputs. Recoil forces were sufficient to move the helicopter rearward while firing at a hover and noticeably slowed the helicopter by an estimated 5 kt in level and diving flight.

37. Time histories of 7 firing sequences are presented in figures 42 through 48. Figures 42 - 44 illustrate the nose down pitching reaction of the hovering helicopter and the control inputs made to avoid projectile ground impact close to the nose of the helicopter. A right yaw rate of an estimated 15 deg/sec was generated by firing the right gun only while hovering. In right sideward flight (figure 45), yaw rate as a result of firing the right gun reached only 9 deg/sec. Rearward and diving flight produced no adverse helicopter response. Intermittent weapon operation is seen during a throttle chop illustrated in figure 48 and is discussed in paragraph 42. Inadvertent, oscillatory cyclic stick inputs in response to vibration, especially in the roll axis, can be seen on the control position traces. Adequate control margins remained during firing to correct attitude changes.

38. No evidence of strikes on the helicopter by links or casings was noted during the APE or previous contractor firing at Edwards AFB, California.

VIBRATION, BLAST, AND NOISE

39. Vibration levels encountered during firing were high as a result of recoil and blast from single or dual weapon operation (POR 5.0). When firing using the sight at the copilot's station, vibration imparted to the sight from the helicopter airframe and the gunner's grip rendered the XM-30 armament system ineffective for engagement of point targets. Isolation of the sight from airframe vibrations will still leave the gunner "in the loop" and degrade the point target capability of the system. Other discrepancies noted during firing were as follows:

a. Pilot's and copilot's doors blown open when firing in or in proximity to the stowed gun position. The installed blast deflector along the aft edge of the door frames proved ineffective. Without additional restraint, the probability of hits and/or loss of doors is high (POR 8.0). The bungee cord restraint fabricated for contractor and USAAVNTA testing is illustrated in photo 2.

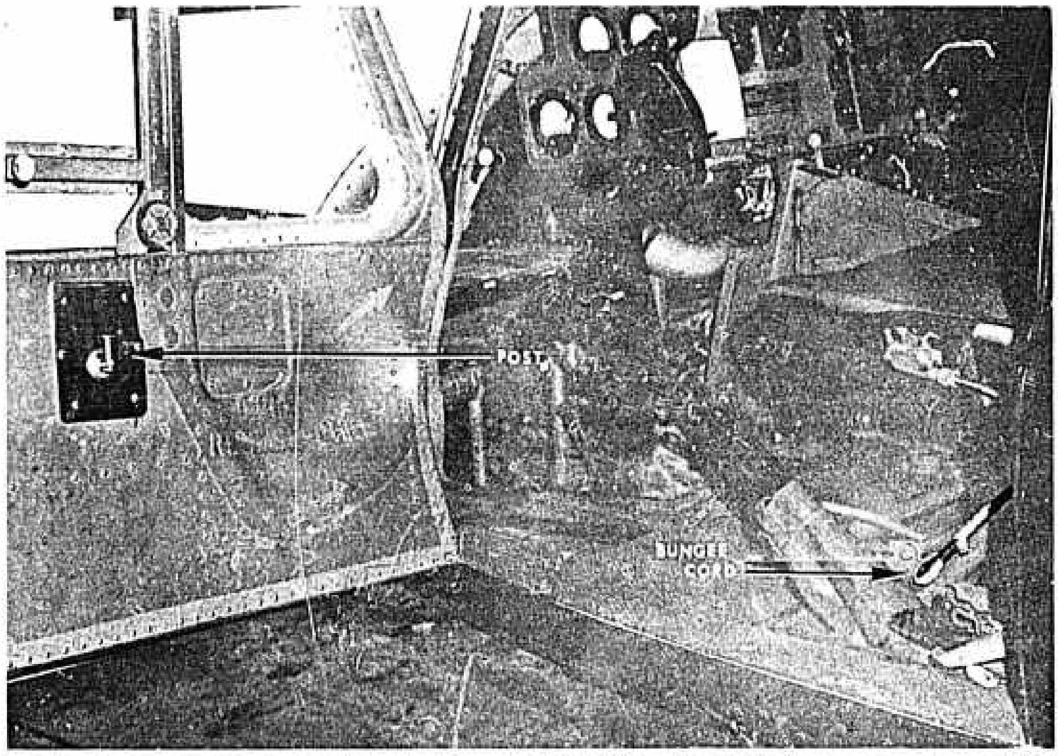


Photo 2 - Door Restraint Secured with Bungee Cord

b. Noise levels of a magnitude sufficient to cause permanent impairment to hearing without the attenuation afforded by the protective helmet, earplugs, and closed windows and doors or a combination thereof. Peak noise levels as high as 165 decibels were recorded by the contractor during previous testing (reference f).

c. Inadvertent turret limit switch contact and resulting gun stoppage caused by vibration when operating within 3.0 to 7.5 degrees of indicated elevation and depression limits respectively.

d. Excessive vibration of the instrument panel resulting in double vision and inability by the pilot or copilot to read instruments (POR 6.0). These levels were previously reported as high as 4.6 to 5.4 g (references f and i).

e. Small cyclic stick oscillations induced by the pilot in response to vibration.

Vibration data acquired during the contractor firing tests conducted at Edwards AFB, California will be published in the report covering that phase of testing.

40. The noise levels and blast pressures encountered during firing (with the protective helmet worn) were not as severe as those experienced by armor, artillery, or other combat units firing large bore weapons; however, the effects of continued exposure to the rapid, sustained fire of the 30 mm gun are unknown.

WEAPON SYSTEM MALFUNCTIONS AND LIMITATIONS

41. It is recognized that the XM-30 armament system is in the development phase and that the XM-140 automatic gun used during the APE was not the most current configuration. Notwithstanding, the demonstrated performance and reliability of the weapon system during the contractor and USAAVNTA testing was poor and unacceptable for its intended mission.

42. Of the 27 APE flights flown on the firing range, 16 flights (59 percent) were aborted because of weapon system malfunctions. It was difficult to achieve a firing burst of sufficient length to record the helicopter response to recoil forces. At times, only 25 linked rounds were loaded in an attempt to alleviate the problem. This problem was compounded by increased incidence of jamming attributed to "g" loads imposed by helicopter maneuvers. Positive "g" could be compensated for by sear adjustment and resulting increased recoil forces; however, negative "g", as encountered during throttle chops

or autorotation entries, caused gun stoppage and jamming. Most of the malfunctions occurring during the test program required partial gun disassembly to clear the weapon. Extensive damage was frequently sustained by live ammunition and a typical result is illustrated in photo 3. As reported in the letter of contractor compliance (reference b), the hazards of using HE ammunition are obvious.

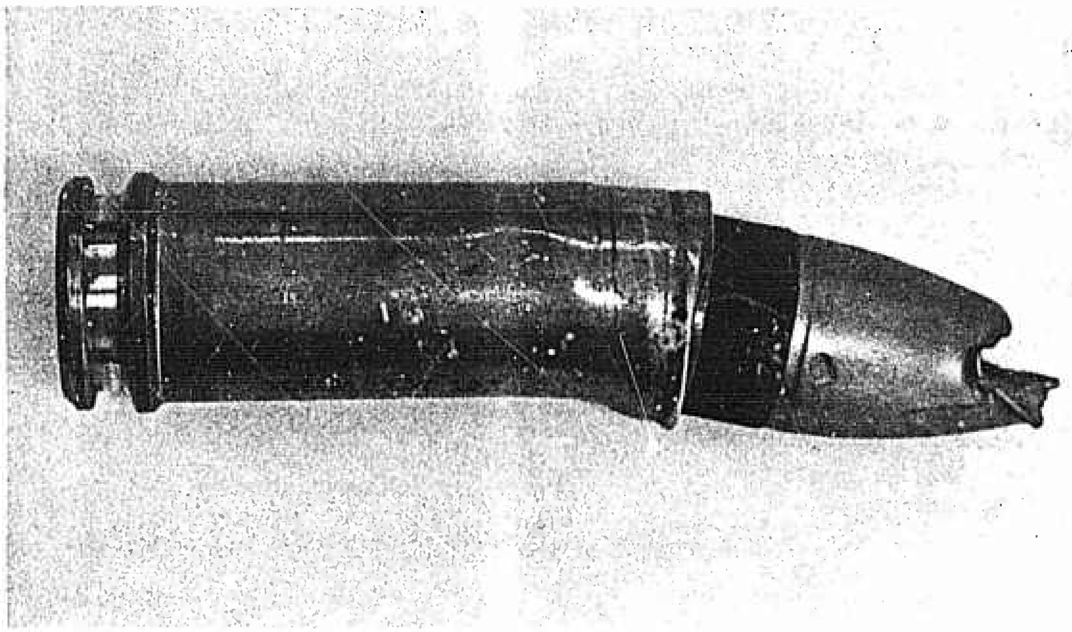


Photo 3 - Damaged Live 30mm Round

43. Traverse or elevation of the turrets to the limits of travel prevented the guns from firing. As mentioned in paragraph 39, vibration during firing with the turrets positioned in proximity to limits, resulted in limit switch contact and gun stoppage. Provision should be made to allow the guns to fire at the design limits. Instrumentation indicated that the limits reached were 7.5 degrees elevation, 42.5 degrees depression, and 55 degrees outboard azimuth which were less than design travel. Another deficiency of the fire control system noted during the test was the failure of the copilot's cyclic trigger to fire the guns. The pilot's cyclic trigger and the copilot's sight grip trigger functioned properly.

44. In addition to the limitations on the sighting system imposed by high vibration levels (paragraph 39), interference with line of sight by the helicopter structure renders the sighting system ineffective for point or small area targets located at large angles of depression and right azimuth.

45. As previously reported by the contractor (references f and i), the gun barrels extend below the helicopter skids when the turrets are fully depressed (photo 4). In event of an electrical system power failure in this position, a safety hazard exists which could result in serious damage to the weapon installation and the helicopter. An autorotational landing would compound the hazard. The capability of elevating the turrets after power failure should be provided.

Photo 4
XM-30 Turrets
At Maximum
Depression

STRESS

46. Component load levels were monitored by the contractor during contractor and the USAAVNTA testing at Edwards AFB. Based on data acquired during previous firing tests, the following components/parameters were considered critical:

a. Upper Turret Braces

b. Longitudinal Turret Braces (Short)

c. Forward Hard Points

d. Elevator Beam Bending

e. Collective Boost Tube

f. Main Rotor Mast Resultant Bending

g. Tail Rotor Blade Beam Bending

h. Tail Boom Longeron Crown Stress

47. A sampling of data acquired during the APE is plotted with contractor data from testing at Ft Hood, Texas (reference f) for five of the components listed above. USAAVNTA data points were recorded during firing at Ft Irwin, California; however, they were not all recorded during a qualified test point firing. The loads presented in figures 49 through 53 were chosen to plot with contractor data and do not, in all cases, represent the highest loads encountered. The results indicated loads consistently higher than earlier contractor data although more in line with recent contractor results (to be published). The highest loads recorded during the APE along with the allowable limits for unrestricted component life are presented in table 4.

As a result of the maximum loads attained and the numerous excursions above the contractor recommended allowable loads, component life must be calculated and component replacement scheduled based on a comprehensive stress analysis.

Table 4. Stress Results.

Component/Parameter	Allowable Load	Maximum Load Recorded	Deviation
Tail Boom Longeron Crown Stress	20,000 psi (peak)	15,830 psi	-20.8%
Tail Rotor Blade Chord Bending at Sta 11.0	±1250 in. lb. (normal)	+4720 in. lb.	+278.0%
Tail Rotor Blade Beam Bending at Sta 11.0	±1800 in. lb. (limit)	+2850 in. lb.	+58.4%
Left Turret Brace (Short) Axial Force	±1300 lb. (Limit)	-2115 lb.	+62.7%
Right Turret Brace (Short) Axial Force	±1300 lb. (Limit)	-3066 lb.	+136.0%

48. Upon completion of the APE, a visual component inspection as specified in the safety of flight release (reference c) was performed and no discrepancies were noted. During the course of a subsequent periodic inspection, 1/2 in. cracks were found on an angle and on a flange on bulkheads located at stations 43 and 52 respectively (under the copilot's floor). The cause of these cracks was undetermined.

Conclusions

49. The following conclusions were reached upon completion of the limited non-firing and firing tests of the UH-1C/XM-30 weapon system:

a. Anticipated degradation of UH-1C level flight performance due to XM-30 installation drag was defined during limited non-firing tests (paragraphs 16 through 21).

b. No objectionable flight characteristics were encountered as a result of the XM-30 installation on the UH-1C helicopter in the firing or non-firing modes (paragraphs 22 through 37).

c. When firing both guns from a hover, a slight nose down pitch occurred which was easily corrected by small longitudinal control inputs. Asymmetric firing produced yaw in the direction of the firing gun (paragraphs 36 and 37).

d. Stress levels on critical components were consistently high and frequently exceeded contractor recommended allowable limits (paragraphs 46 and 47).

e. Pilot's and copilot's doors were blown open when firing the guns near zero elevation and traverse (paragraph 39).

f. Gun malfunctions frequently subjected live ammunition to damage, the nature of which indicated the inadvisability of using HE ammunition (paragraph 42).

g. At full limits of depression, the guns extend below the level of the helicopter skids and would remain there in event of an electrical system power failure (paragraph 45).

h. The reliability of the XM-140 automatic gun system was poor and unacceptable for its intended mission (paragraph 42).

i. Noise levels during firing are of a magnitude sufficient to cause permanent impairment to hearing without proper attenuation (paragraphs 39 and 40).

j. The G.W. of the UH-1C/XM-30 weapon system and resulting performance limitations degrade the armed mission capability of the helicopter (paragraph 15).

k. High vibration levels during firing render the point target capability of the weapon system ineffective (paragraph 39).

l. The guns did not fire at turret limits of elevation and/or traverse (paragraph 43).

m. Excessive vibration of the instrument panel during firing resulted in inability to read instruments. The accelerations recorded during previous testing are in excess of those intended and guaranteed for instrument integrity (paragraph 39).

Recommendations

50. The following recommendations are made for acceptable helicopter operation and armed mission capability:

a. Critical component life calculation and replacement schedules must be determined after stress analysis (paragraphs 46 and 47).

b. A restraint system or improved door design must be incorporated in the UH-1C to prevent pilot and copilot doors opening during firing (paragraph 39).

c. Continued investigation and resolution of the gun malfunctions causing severe damage to live ammunition is necessary prior to the use of HE rounds (paragraph 42).

d. A means of elevating the guns in event of power failure should be provided (paragraph 45).

e. The reliability of the XM-140 automatic gun system should be improved prior to further U. S. Army testing (paragraph 42).

f. Mandatory use of the protective helmet and earplugs by crewmembers should be reflected in the Operator's Manual (paragraphs 39 and 40).

51. The following recommendations are made for improved helicopter operation and armed mission capability:

a. Gross weight reductions must be achieved if the UH-1C/XM-30 is to be effectively utilized (paragraph 15).

b. A reduction in vibration levels or modification of the sight installation is necessary to retain the point target capability of the system (paragraph 39).

c. Provision should be made to allow the guns to fire at turret limits of elevation and traverse (paragraph 43).

52. If the XM-30 installation is adopted for the UH-1C helicopter, level flight performance data from this report and appropriate contractor results should be incorporated in the Operator's Manual (paragraphs 16 through 21).

APPENDIX I

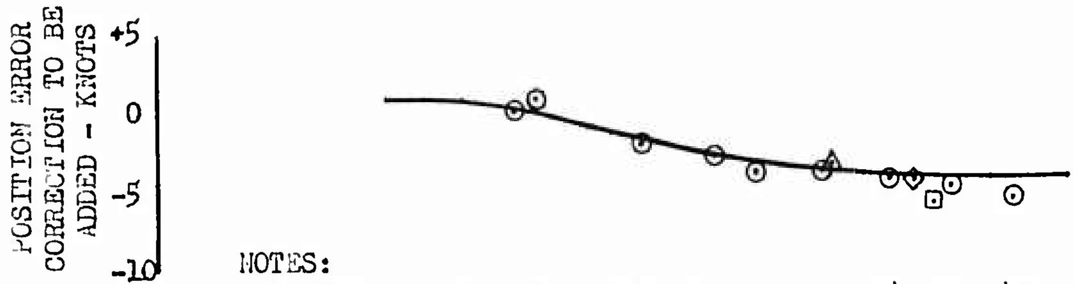
TEST DATA

FIGURE NO. 1
AIRSPEED CALIBRATION
UH-1C/XM-30 S/N 64-14102

PRODUCTION SYSTEM

ROTOR SPEED = 324 RPM
DENSITY ALT = 3360 FT.
AVG. GROSS WEIGHT = 8190 LB.

C.G. LOCATION = STA 134.0 (aft)
GROUND SPEED COURSE
XM-30 IN STOWED POSITION



NOTES:
1. Curves taken from Bell Report No. 204-100-147.
2. Calibrated Airspeed = Instrument Corrected Airspeed + Position Error. $V_{CAL} = V_{IC} + \Delta V_{P.E.}$

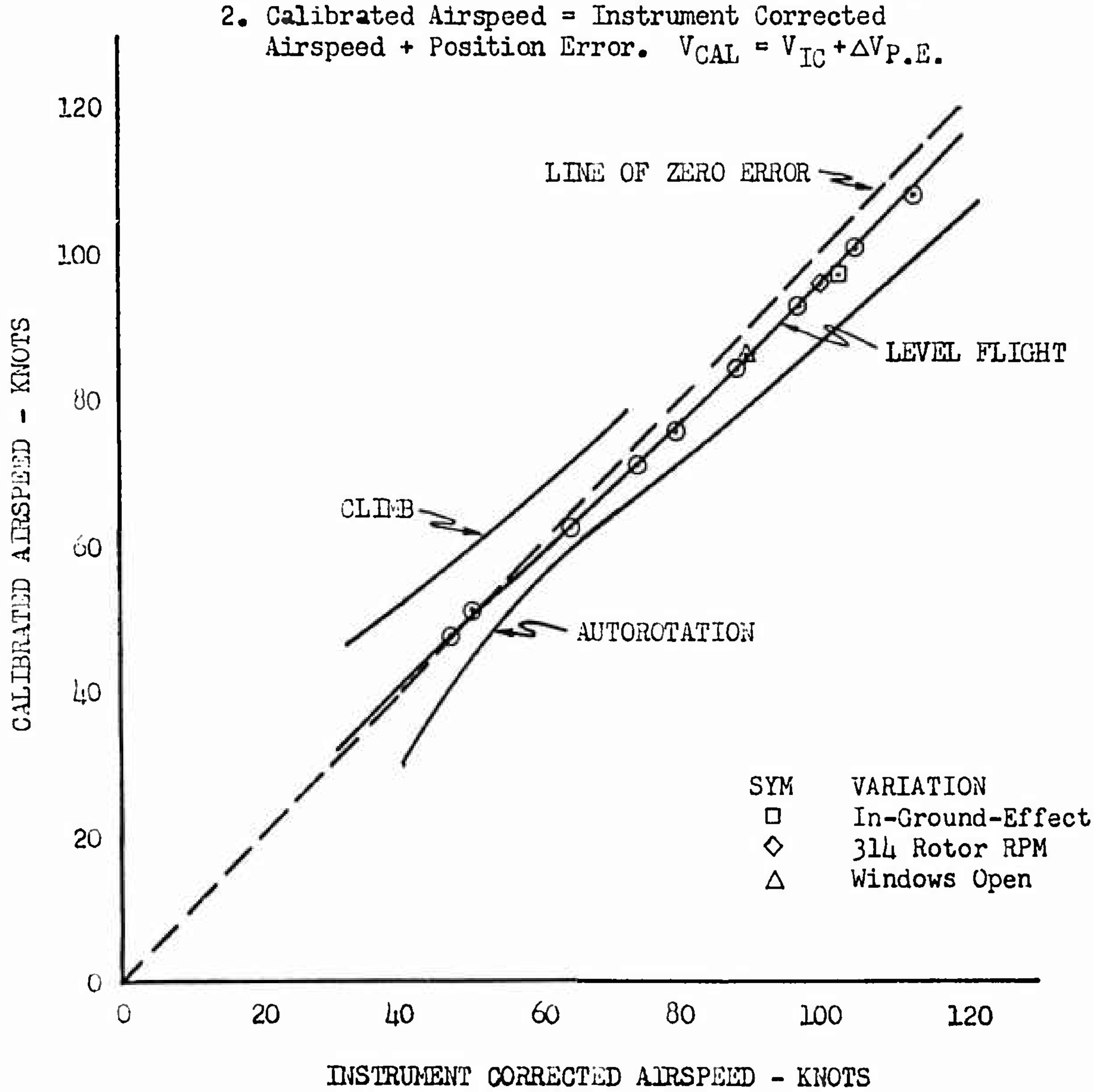


FIGURE NO. 2
NON-DIMENSIONAL LEVEL FLIGHT PERFORMANCE
UH-1C/XM-30 S/N 64-14102

NOTES:

1. Broken lines taken from USAAVNTA Report No. 64-28. (Ref. e)
2. Shaded symbols and dashed lines denote 314 Rotor RPM.
3. Open symbols, solid lines, and dash-dot lines denote 324 Rotor RPM.
4. Data points derived from Figure Nos. 7 thru 11.

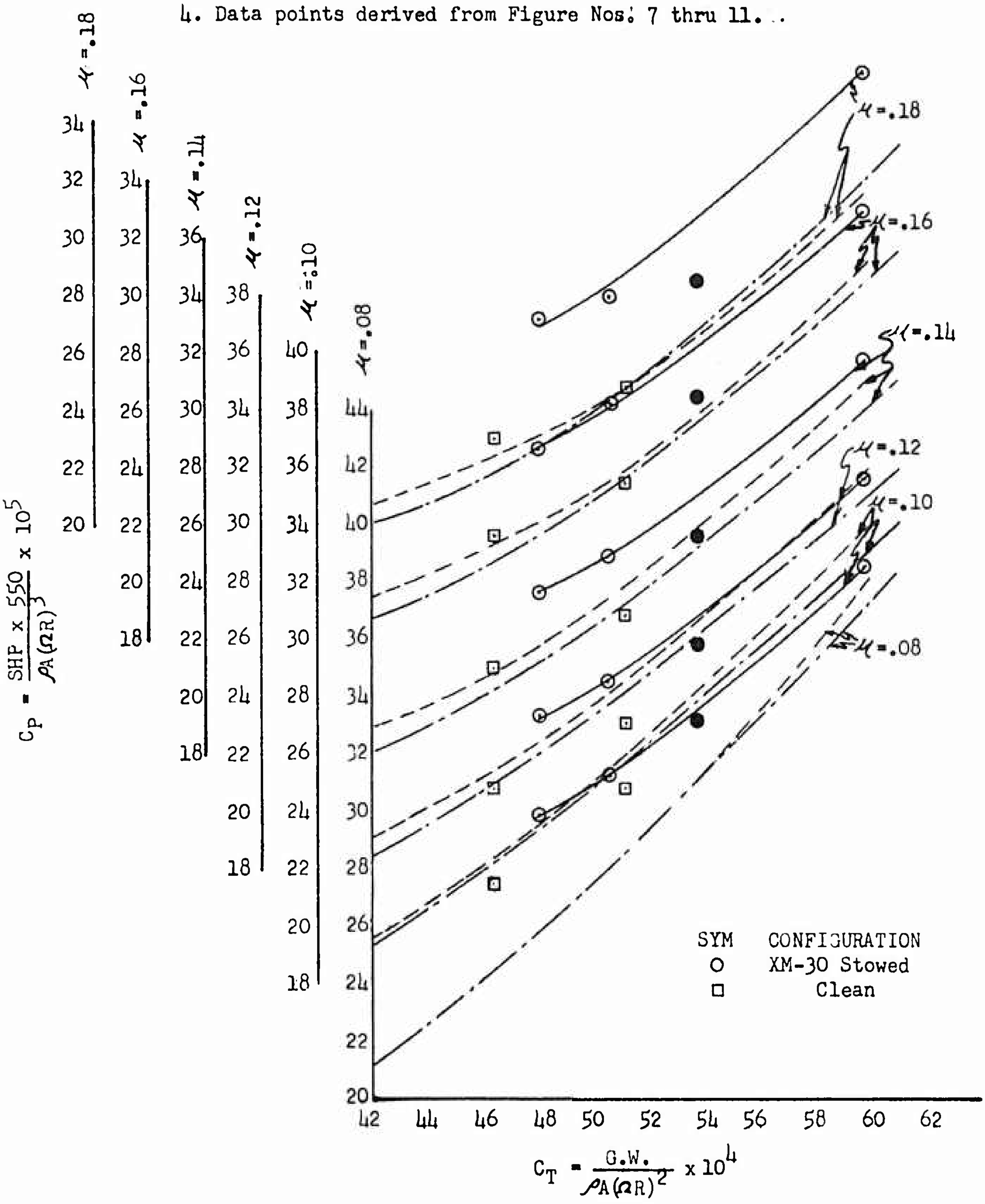


FIGURE NO. 3
NON-DIMENSIONAL LEVEL FLIGHT PERFORMANCE
UH-1C/XM-30 S/N 64-14102

NOTES:

1. Broken lines taken from USAAVNTA Report No. 64-28. (Ref. e)
2. Shaded symbols and dashed lines denote 314 Rotor RPM.
3. Open symbols, solid lines, and dash-dot lines denote 324 Rotor RPM.
4. Data points derived from Figure Nos. 7 thru 11.

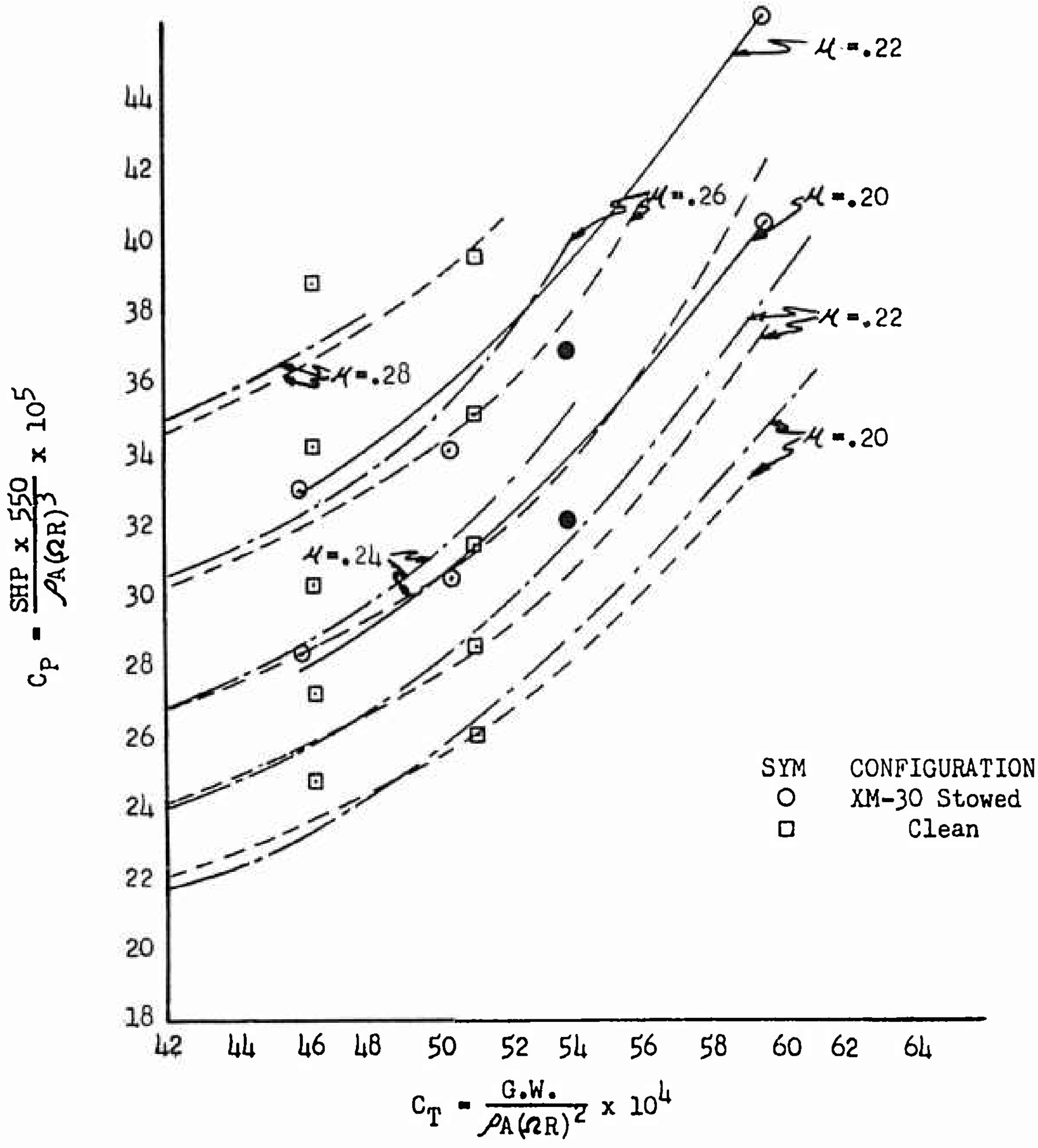


FIGURE NO. 4
RANGE SUMMARY
UH-1C/XM-30 S/N 64-14102

STANDARD DAY
5000 FT.
324 ROTOR RPM

NOTES:

1. Broken line taken from USAAVNTA Report No. 64-28 (Ref. e)
2. Points derived from Figure No. 5.

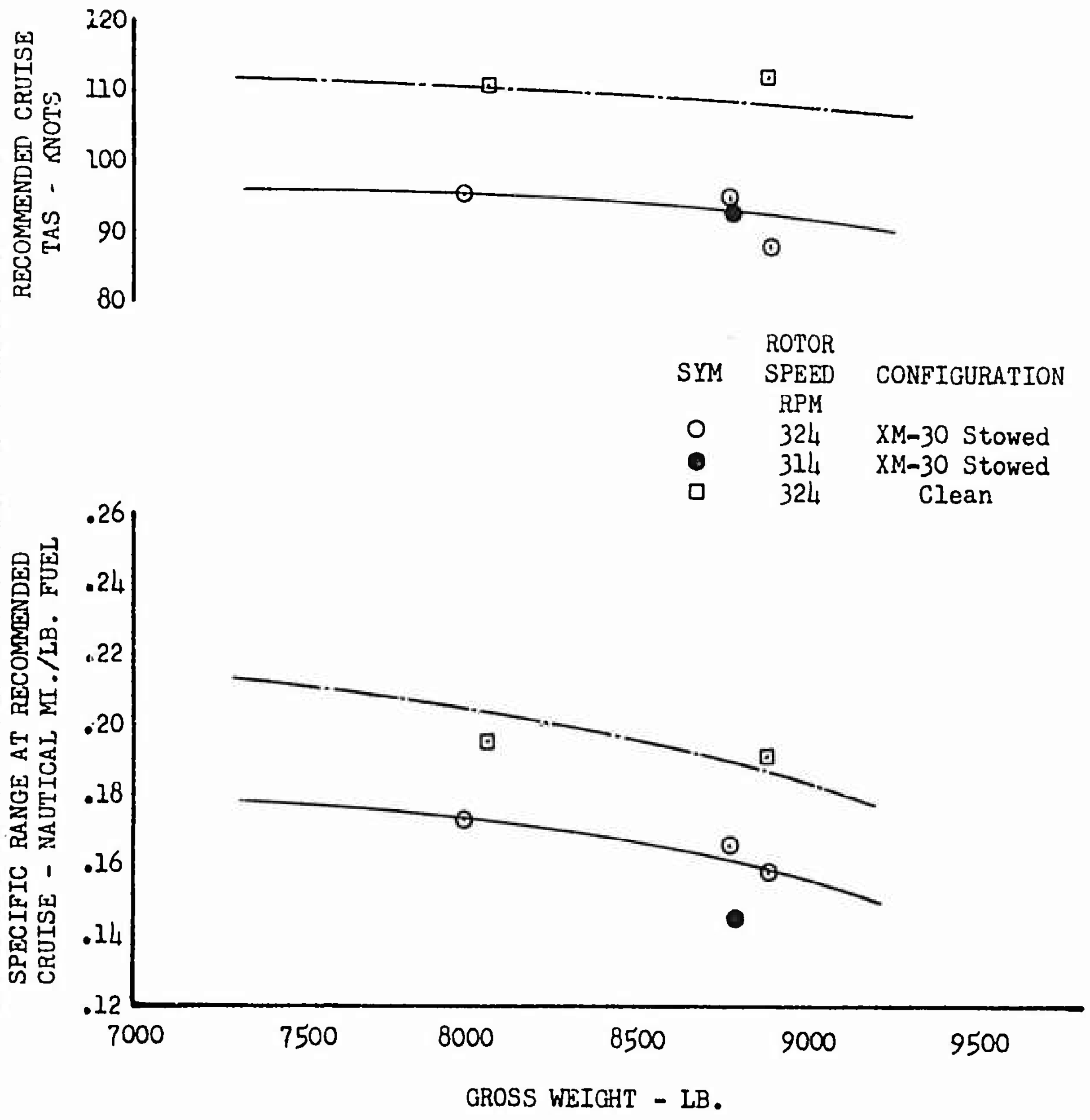
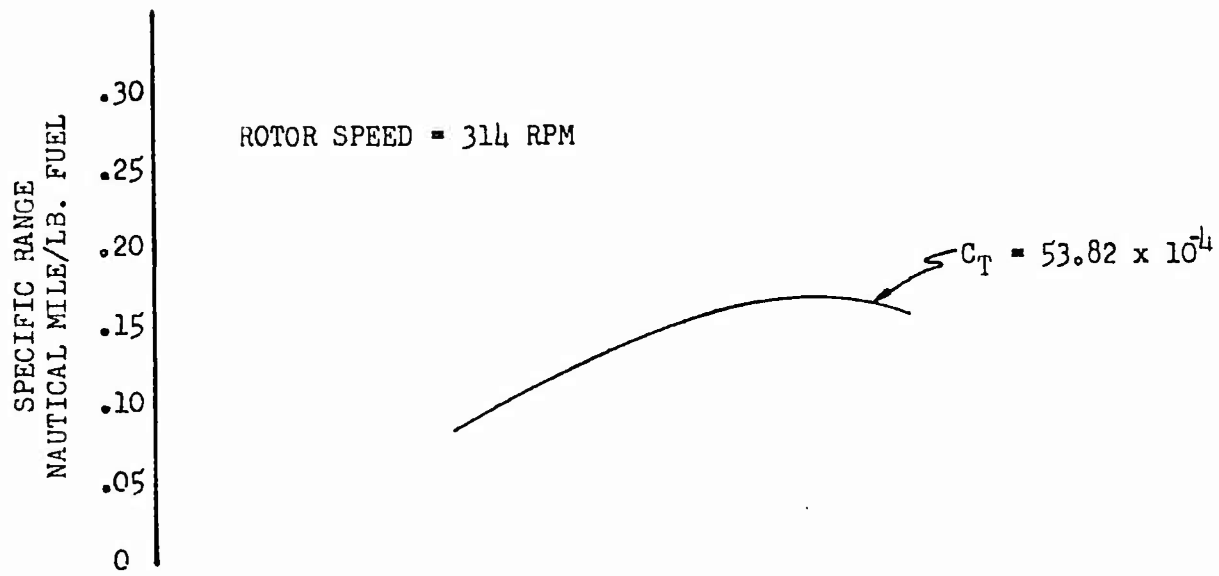


FIGURE NO. 5
LEVEL FLIGHT PERFORMANCE
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION

NOTES:
1. Dashed line denotes clean configuration.
2. Curves derived from Figure Nos. 7 thru 11 and 16.



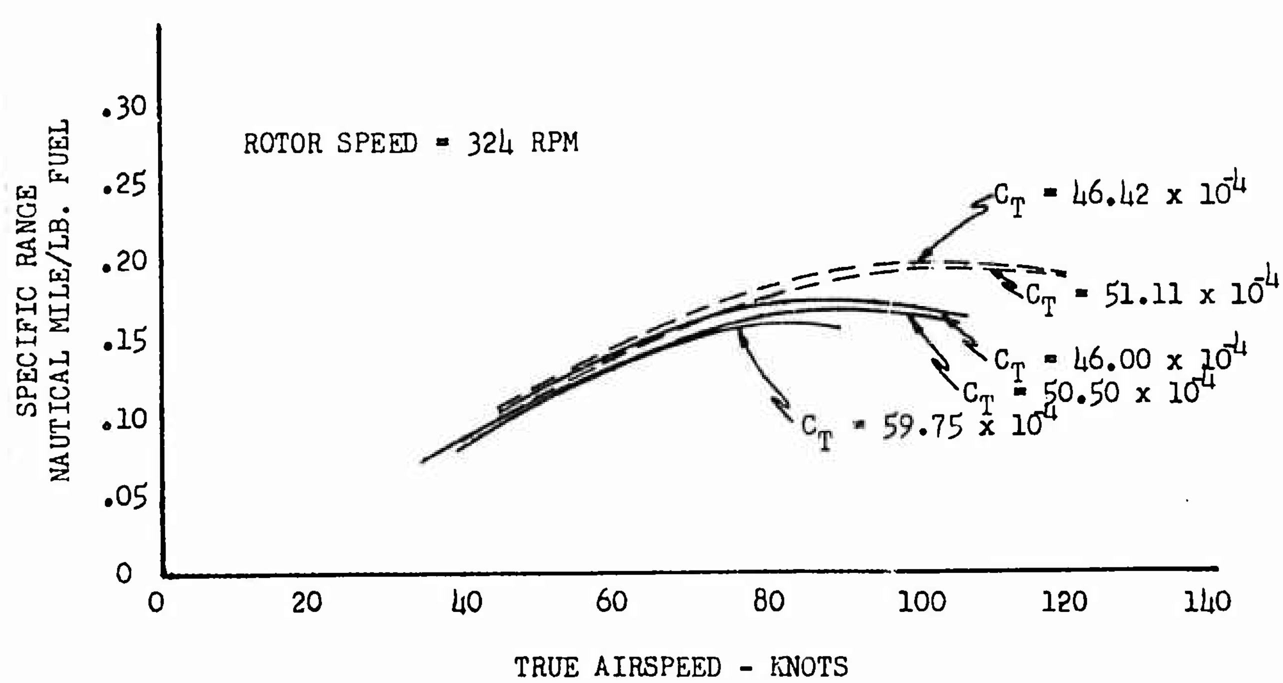


FIGURE NO. 6
MAXIMUM AIRSPEED
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION
STANDARD DAY
324 ROTOR RPM
MID C.G. LOCATION
NORMAL RATED POWER

NOTE: Curves derived from Figure Nos. 2, 3, and 14
Broken lines indicate engine mechanical limits.

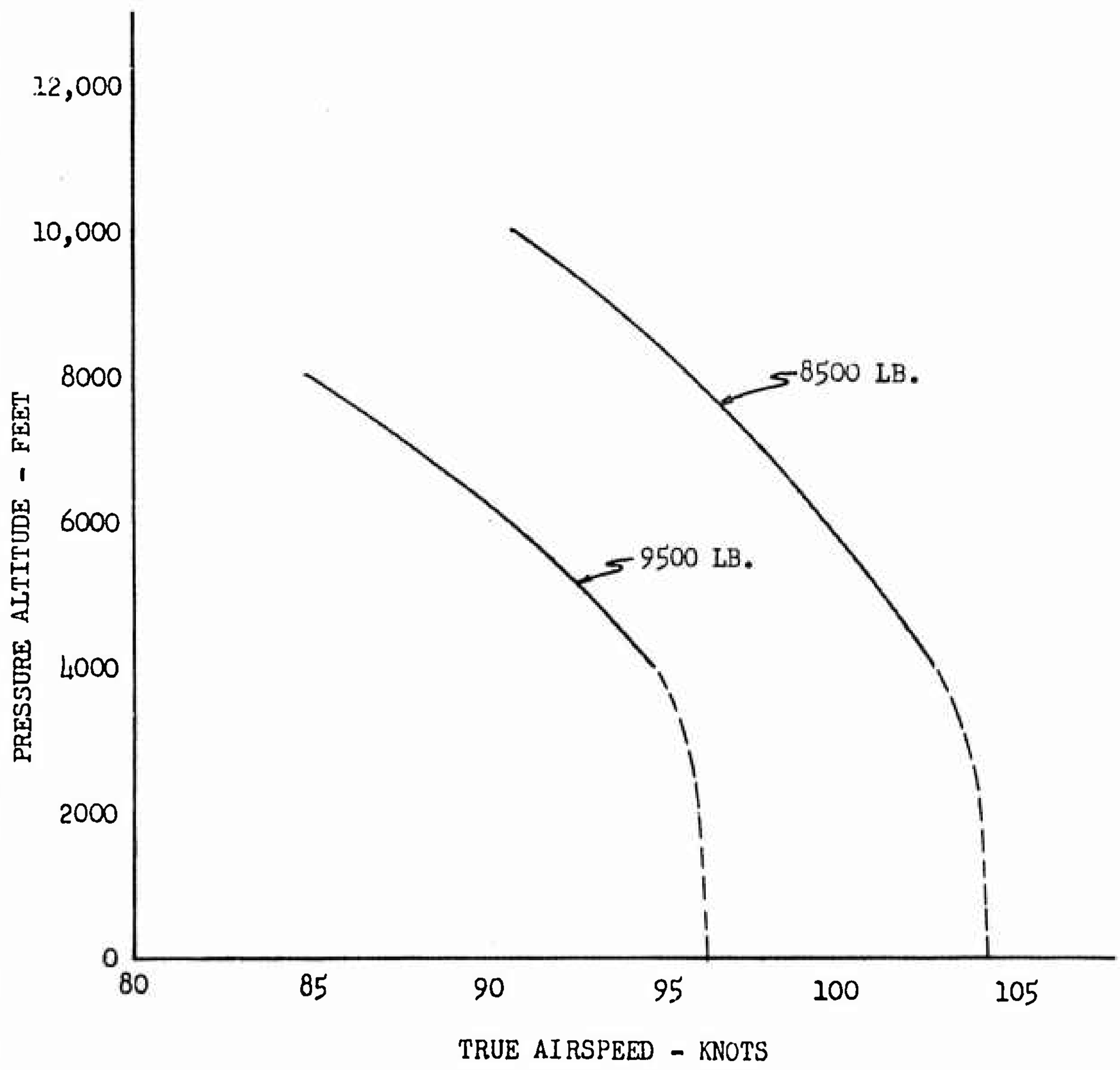


FIGURE NO. 7
LEVEL FLIGHT PERFORMANCE
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION

ROTOR SPEED = 324 RPM
DENSITY ALTITUDE = 5000 FT.
GROSS WEIGHT = 7980 LB.
C.G. LOCATION = STA 130.1 (mid)
C_T AVG. = 46.00×10^{-4}

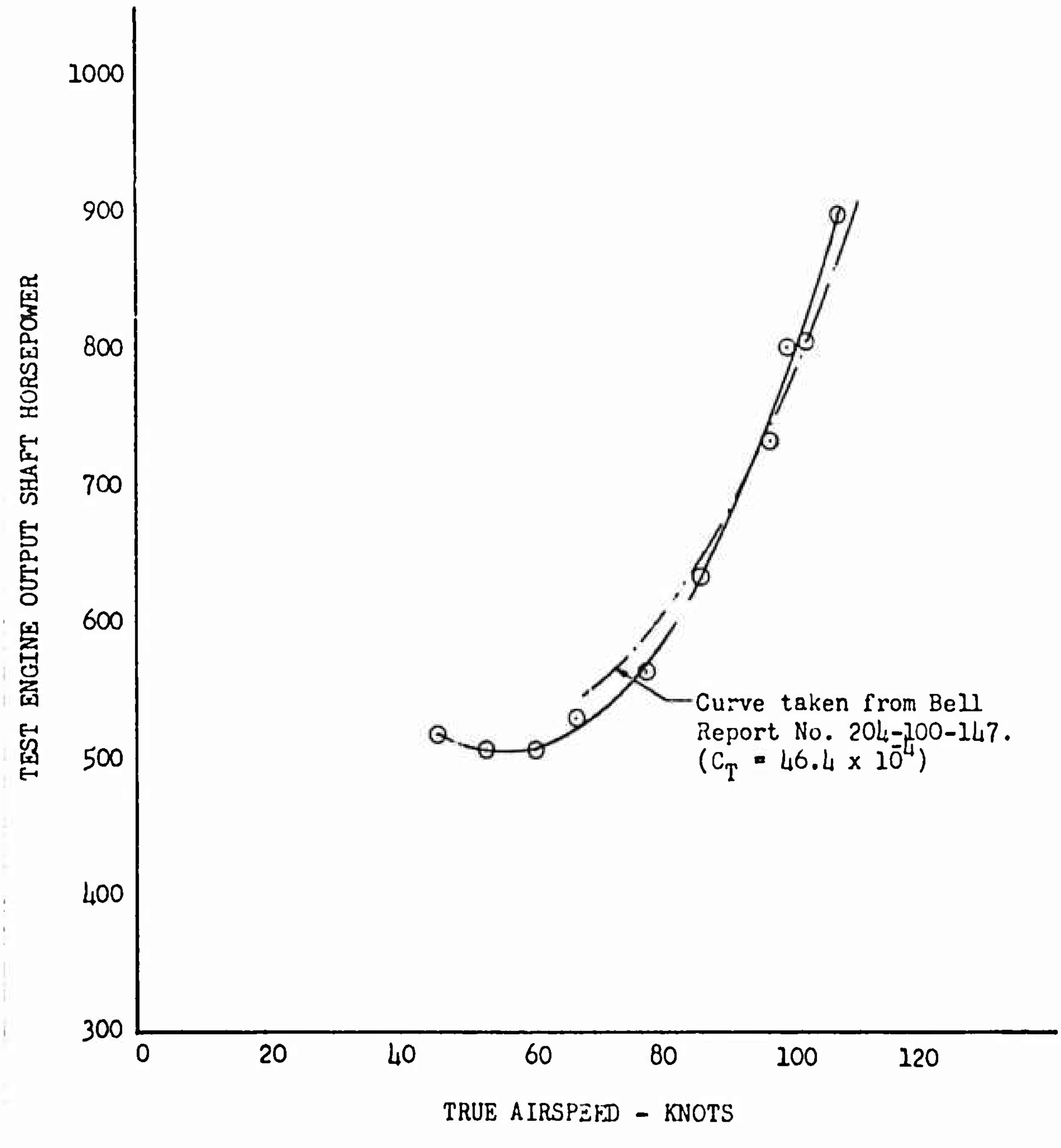


FIGURE NO. 8
LEVEL FLIGHT PERFORMANCE
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION

ROTOR SPEED = 324 RPM
DENSITY ALT = 5000 FT.
GROSS WEIGHT = 8760 LB.
C.G. LOCATION = STA 130.6 (mid)
C_T AVG. = 50.50 x 10^{4}

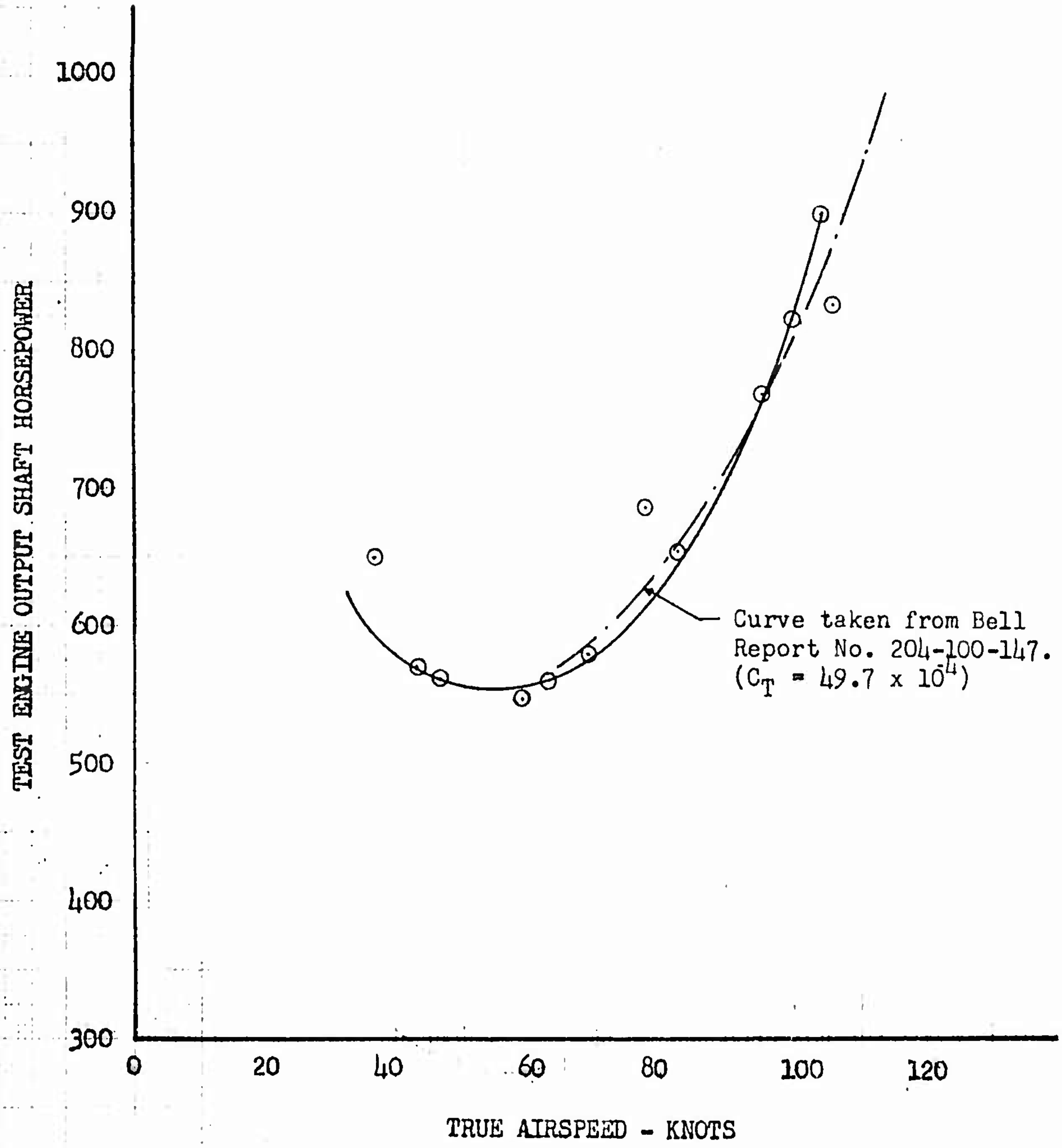


FIGURE NO. 9
LEVEL FLIGHT PERFORMANCE
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION

ROTOR SPEED = 324 RPM
DENSITY ALT = 10000 FT.
GROSS WEIGHT = 8880 LB.
C.G. LOCATION = STA 130.1 (mid)
C_T AVG. = 59.71 x 10^{-4}

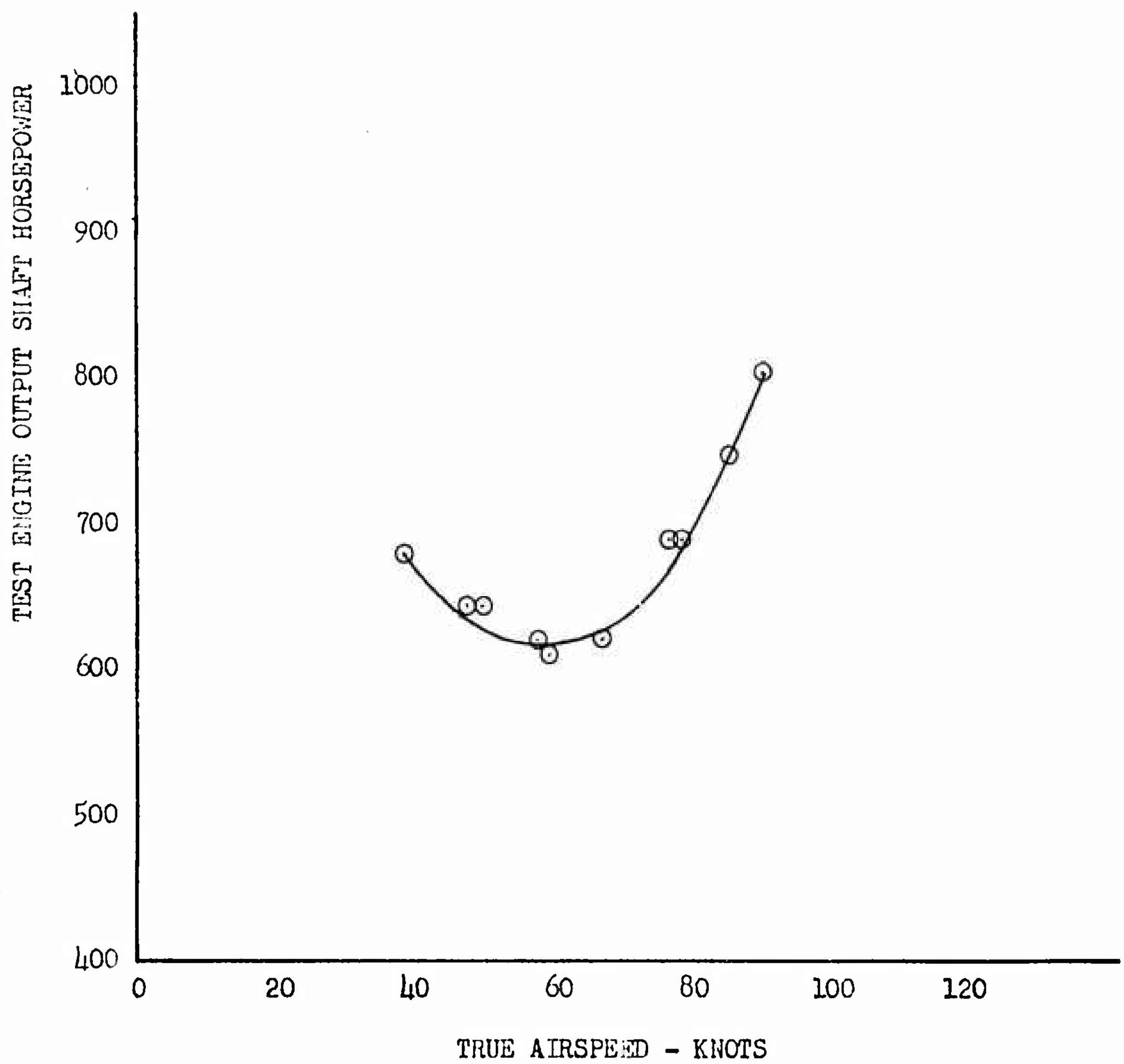


FIGURE NO. 10
LEVEL FLIGHT PERFORMANCE
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION

ROTOR SPEED = 314 RPM
DENSITY ALT = 5000 FT.
GROSS WEIGHT = 8770 LB.
C.G. LOCATION = STA 130.8 (mid)
C_T AVG. = 53.82×10^{4}

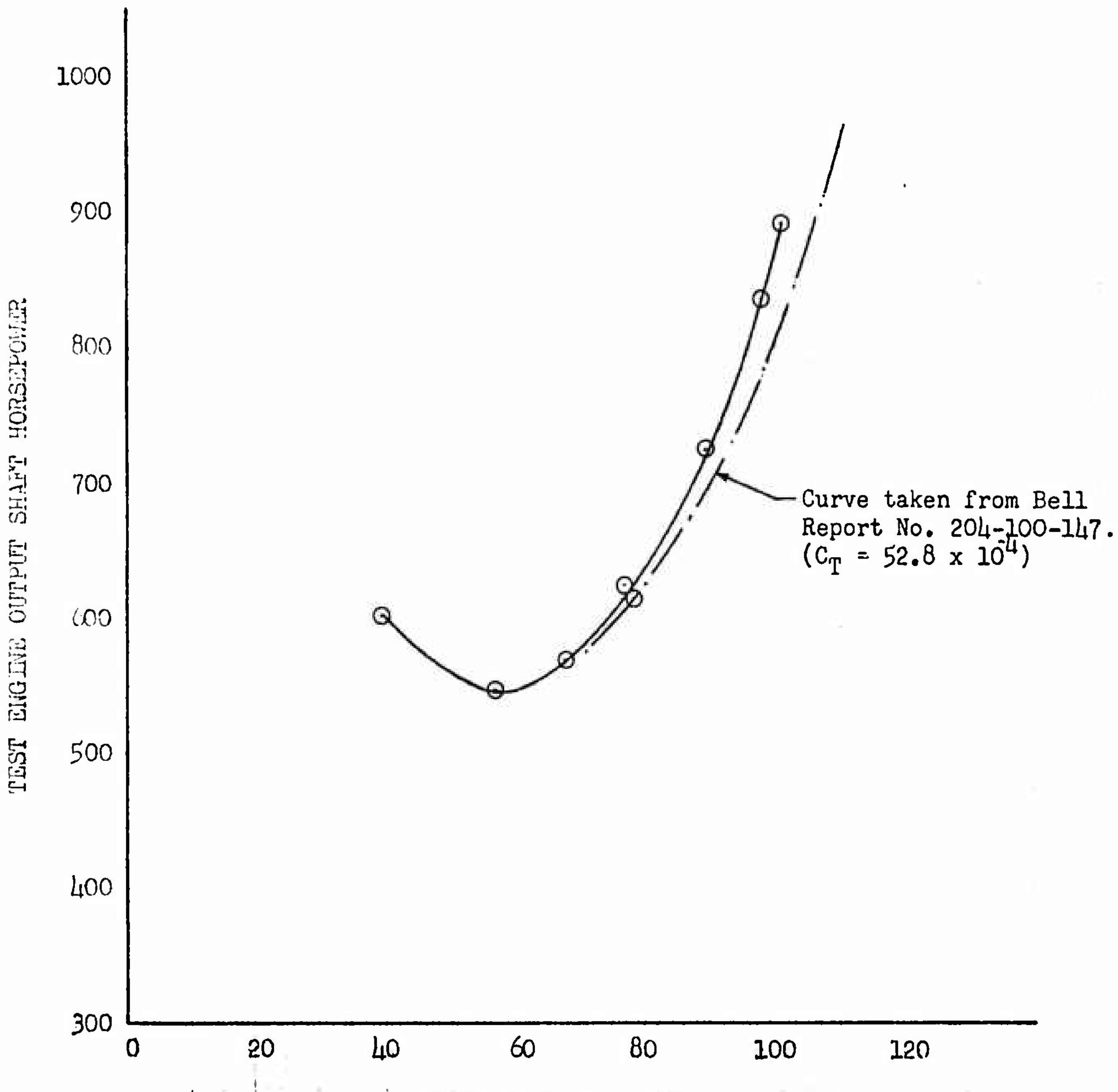


FIGURE NO. 11
LEVEL FLIGHT PERFORMANCE
UH-1C/XM-30 S/N 64-14102

CLEAN CONFIGURATION

ROTOR SPEED = 324 RPM
DENSITY ALT = 5000 FT.
GROSS WEIGHT = 8050 LB.
C.G. LOCATION = STA 130.5 (mid)
C_T AVG. = 46.42×10^{-4}

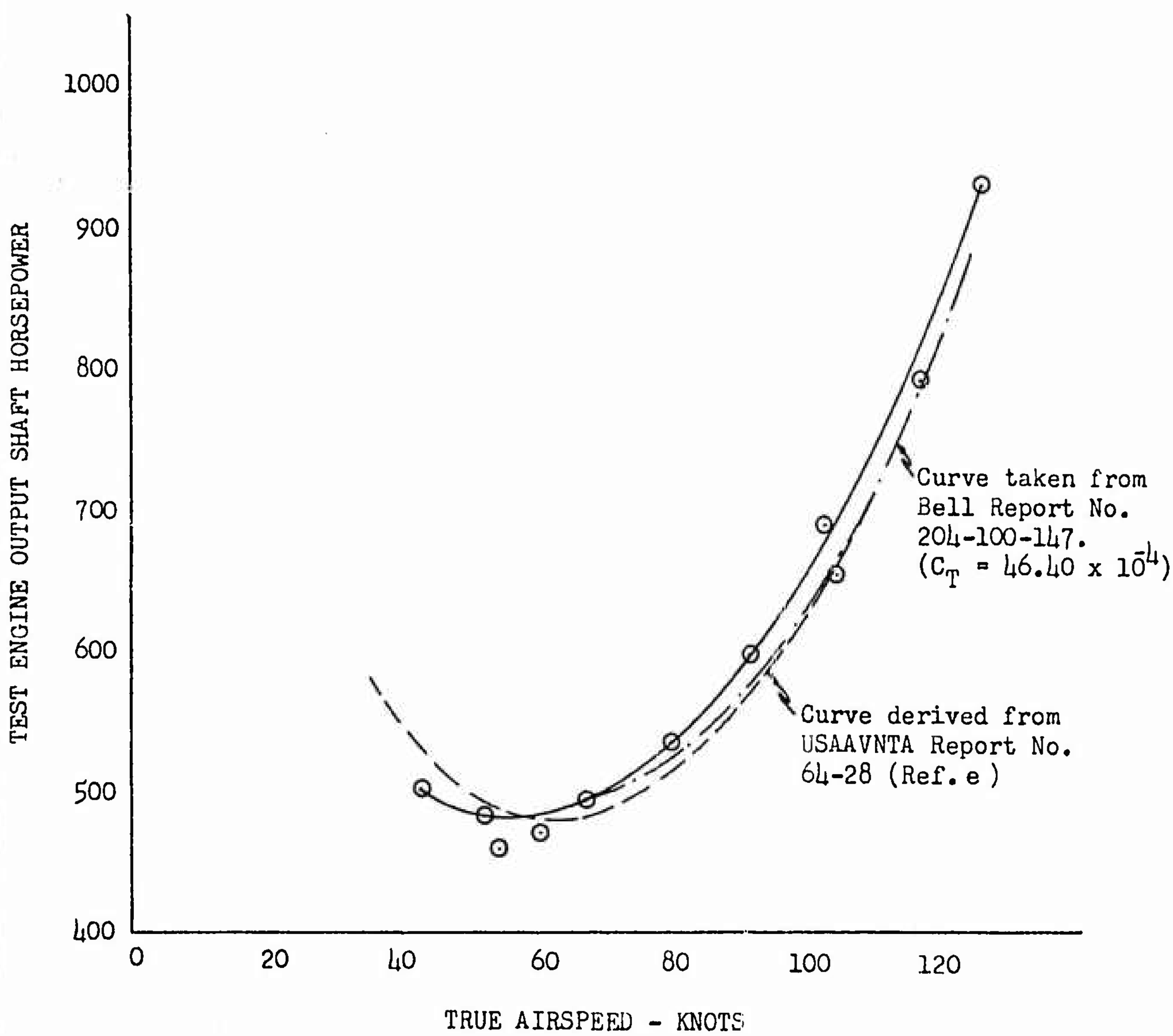


FIGURE NO. 12
LEVEL FLIGHT PERFORMANCE
UH-1C/XM-30 S/N 64-14102

CLEAN CONFIGURATION

ROTOR SPEED = 324 RPM
DENSITY ALT = 5000 FT.
GROSS WEIGHT = 8870 LB.
C.G. LOCATION = STA 130.5 (mid)
C_T AVG. = 51.11 x 10^{4}

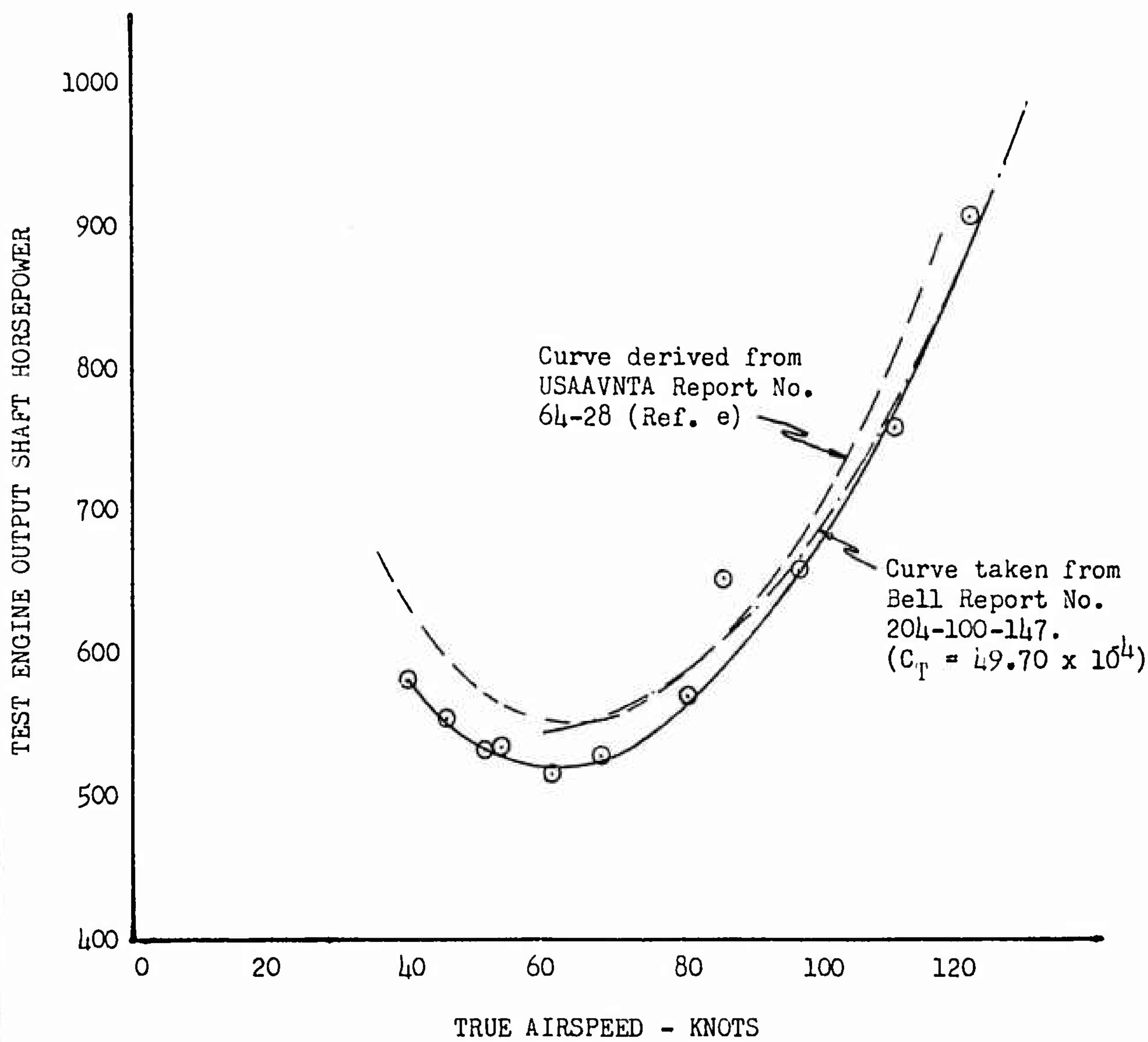


FIGURE NO. 13
LEVEL FLIGHT PERFORMANCE
UH-1C/XM-30 S/N 64-14102

ROTOR SPEED = 324 RPM
DENSITY ALT = 5500 FT.
GROSS WEIGHT = 8200 LB.
C_T AVG. = 48.60×10^{-4}

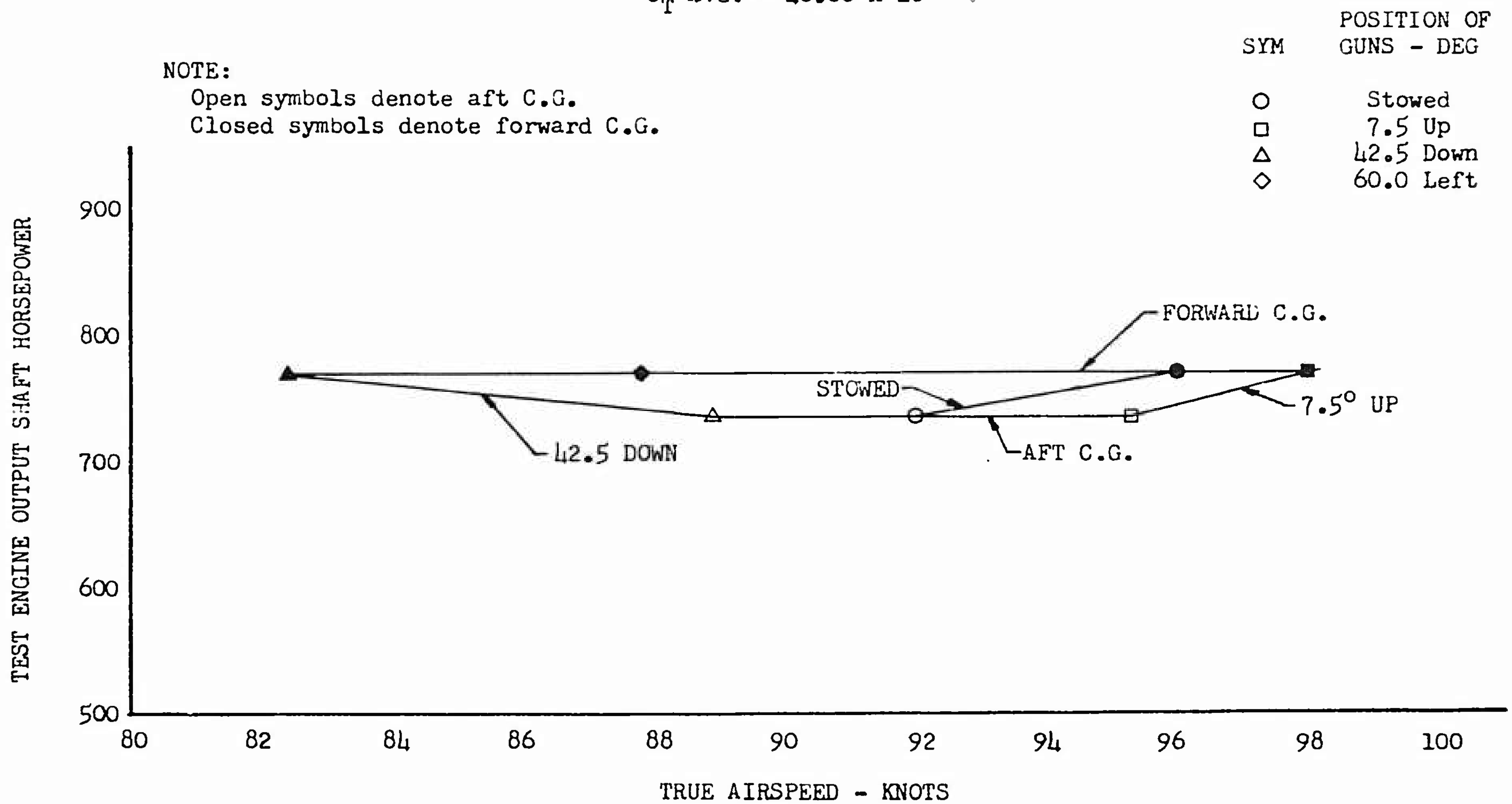


FIGURE NO. 14
SHAFT HORSEPOWER AVAILABLE
UH-1C/XM-30 S/N 64-14102
NORMAL RATED POWER

NOTES: Curves taken from USAAVNTA Report No. 64-28 (Ref. e)

1. Shaft Horsepower Available based on Lycoming T53-L-11 Engine Model Specification.
2. Compressor Inlet Temperature Rise = +2°C
3. Compressor Inlet Pressure Ratio $\left(\frac{P_{T_2}}{P_A}\right) = 1.00$
4. Generator Electrical Load = Zero
5. Percent Air Bleed $\left(\frac{W_{bl}}{W_A}\right) = 0.5\%$
6. Rotor Speed = 324 RPM

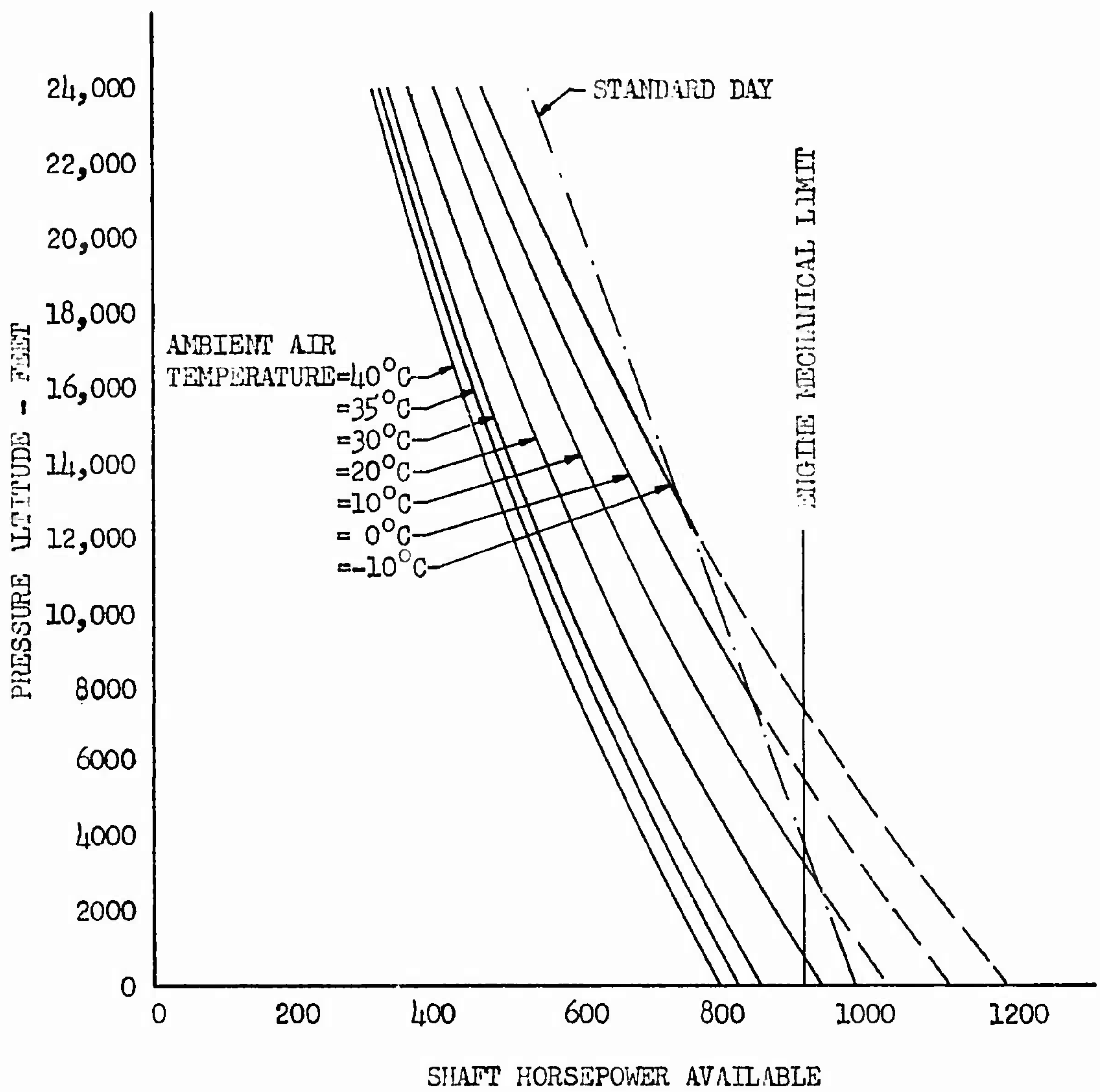


FIGURE NO. 15
SHAFT HORSEPOWER AVAILABLE
UH-1C/XM-30 S/N 64-14102
TAKEOFF LIMIT POWER

NOTES: Curves taken from USAAVNTA Report No. 64-28 (Ref. e)

1. Shaft Horsepower Available based on Lycoming T53-L-11 Engine Model Specification.
2. Compressor Inlet Temperature Rise = +2°C
3. Compressor Inlet Pressure Ratio $\left(\frac{P_{T_2}}{P_A}\right) = 1.00$
4. Generator Electrical Load = Zero
5. Percent Air Bleed $\left(\frac{W_{bl}}{W_A}\right) = 0.5\%$
6. Rotor Speed = 324 RPM

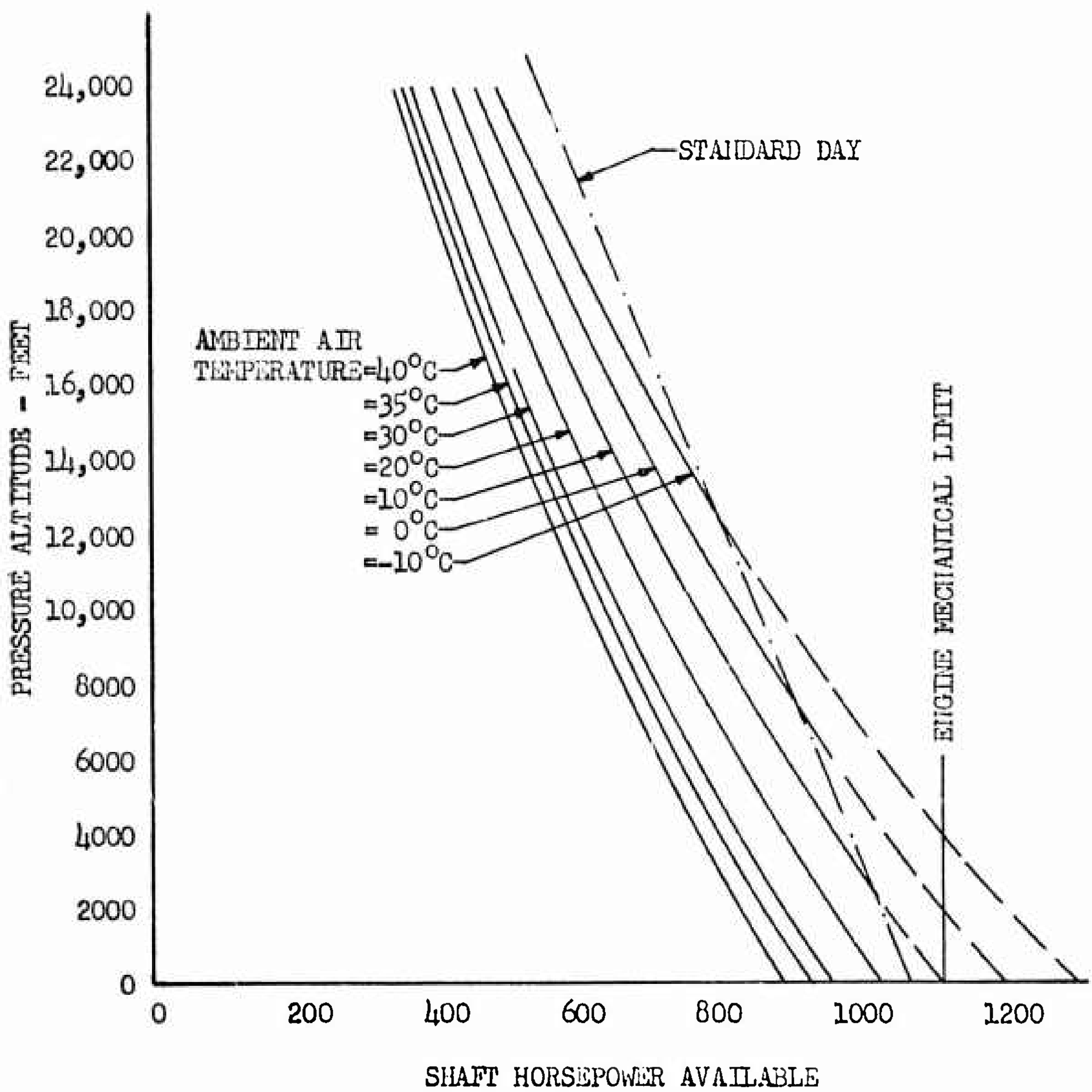
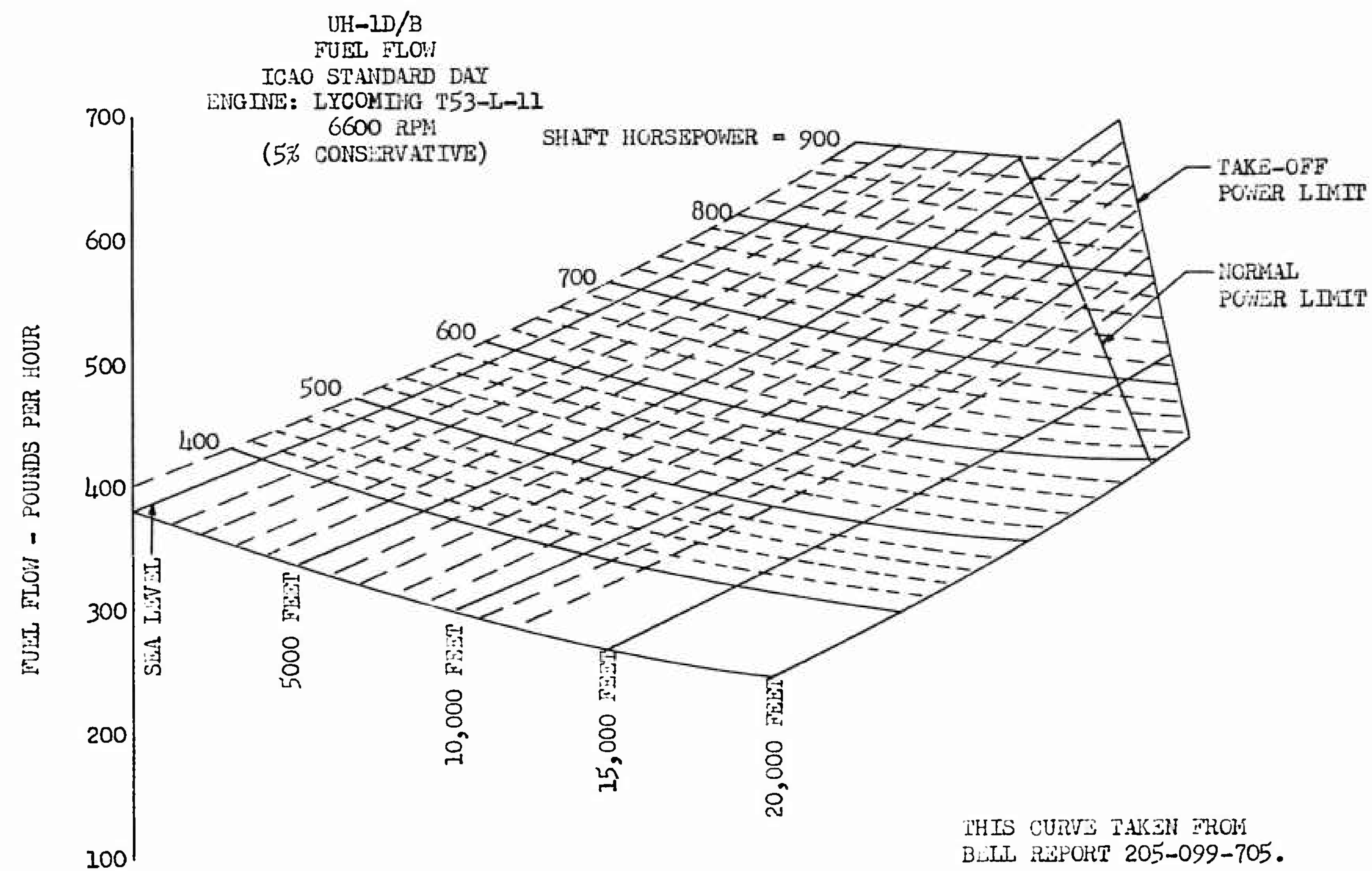


FIGURE NO. 16
SPECIFICATION FUEL FLOW
UH-1C USA S/N 64-14102
BELL MODEL 540 ROTOR SYSTEM



THIS CURVE TAKEN FROM
BELL REPORT 205-099-705.

FIGURE NO. 18
CONTROL POSITION TRIM CURVES
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION

SYM	DENSITY ALTITUDE FT.	GROSS WEIGHT LB.	ROTOR SPEED RPM	C.G. LOCATION STA	FLIGHT CONDITION
O	10970	8590	324	130.1 (mid)	Level Flight

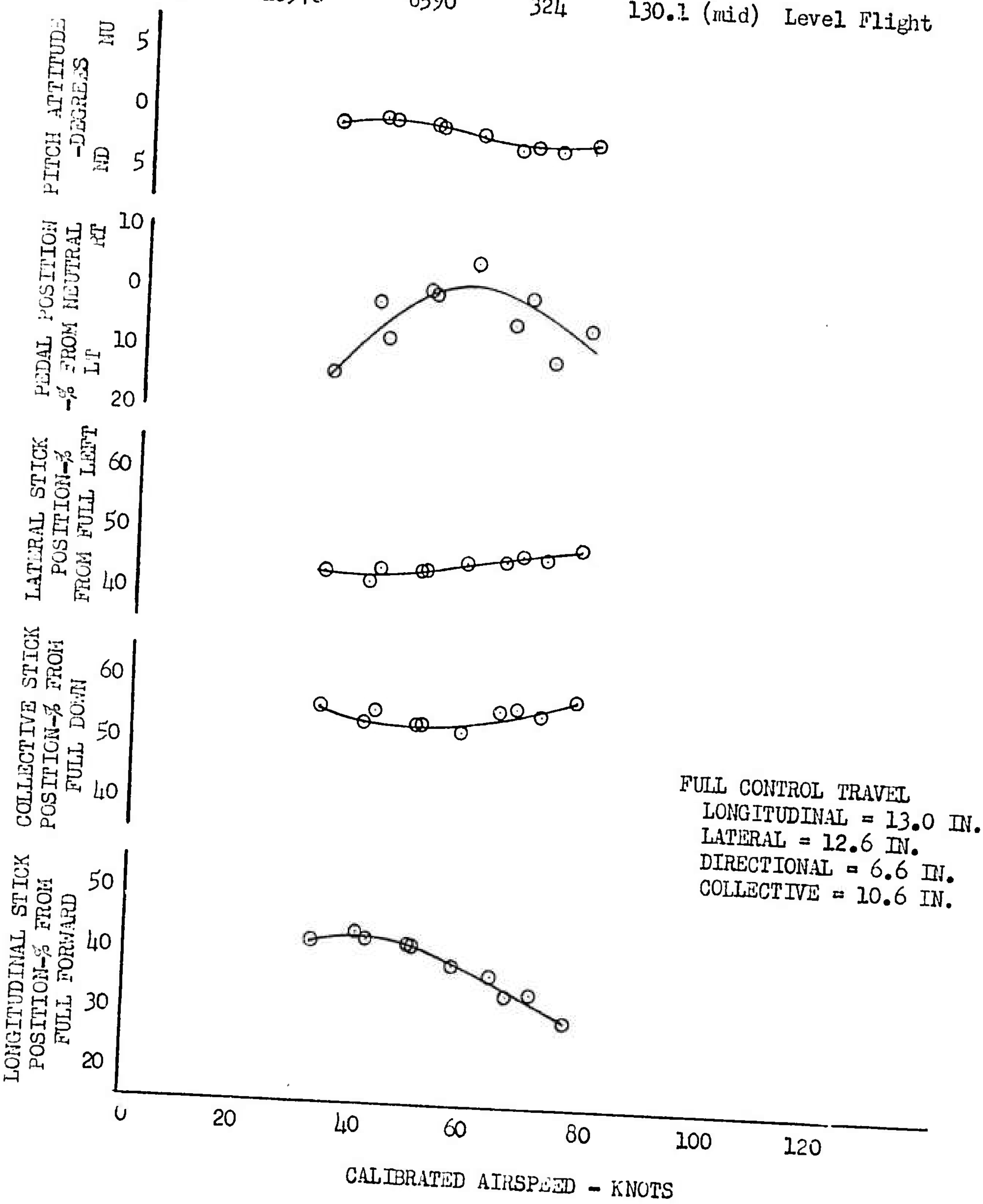


FIGURE NO. 17
CONTROL POSITION TRIM CURVES
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION

SYM	DENSITY ALTITUDE FT.	GROSS WEIGHT LB.	ROTOR SPEED RPM	C.G. LOCATION STA	FLIGHT CONDITION
○	5720	7840	324	130.1 (mid)	Level Flight
□	5000	8050	324	130.5 (mid)	Level Flight (Clean)

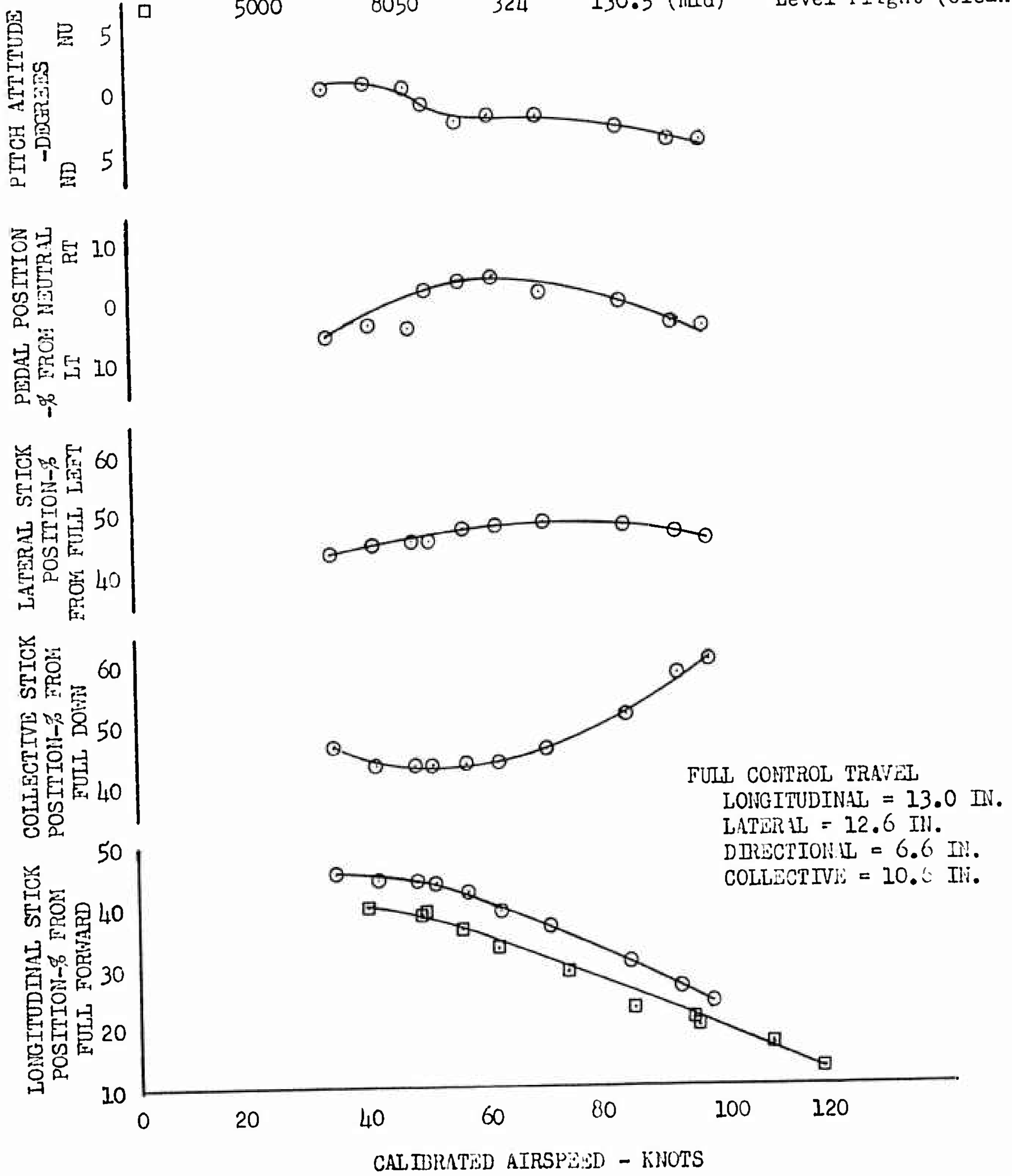


FIGURE NO. 19
CONTROL POSITION TRIM CURVES
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION

SYM	DENSITY ALTITUDE FT.	GROSS WEIGHT LB.	ROTOR SPEED RPM	C.G. LOCATION STA	FLIGHT CONDITION
O	5800	8580	324	130.6 (mid)	Level Flight
□	5000	8870	324	130.5 (mid)	Level Flight (Clean)

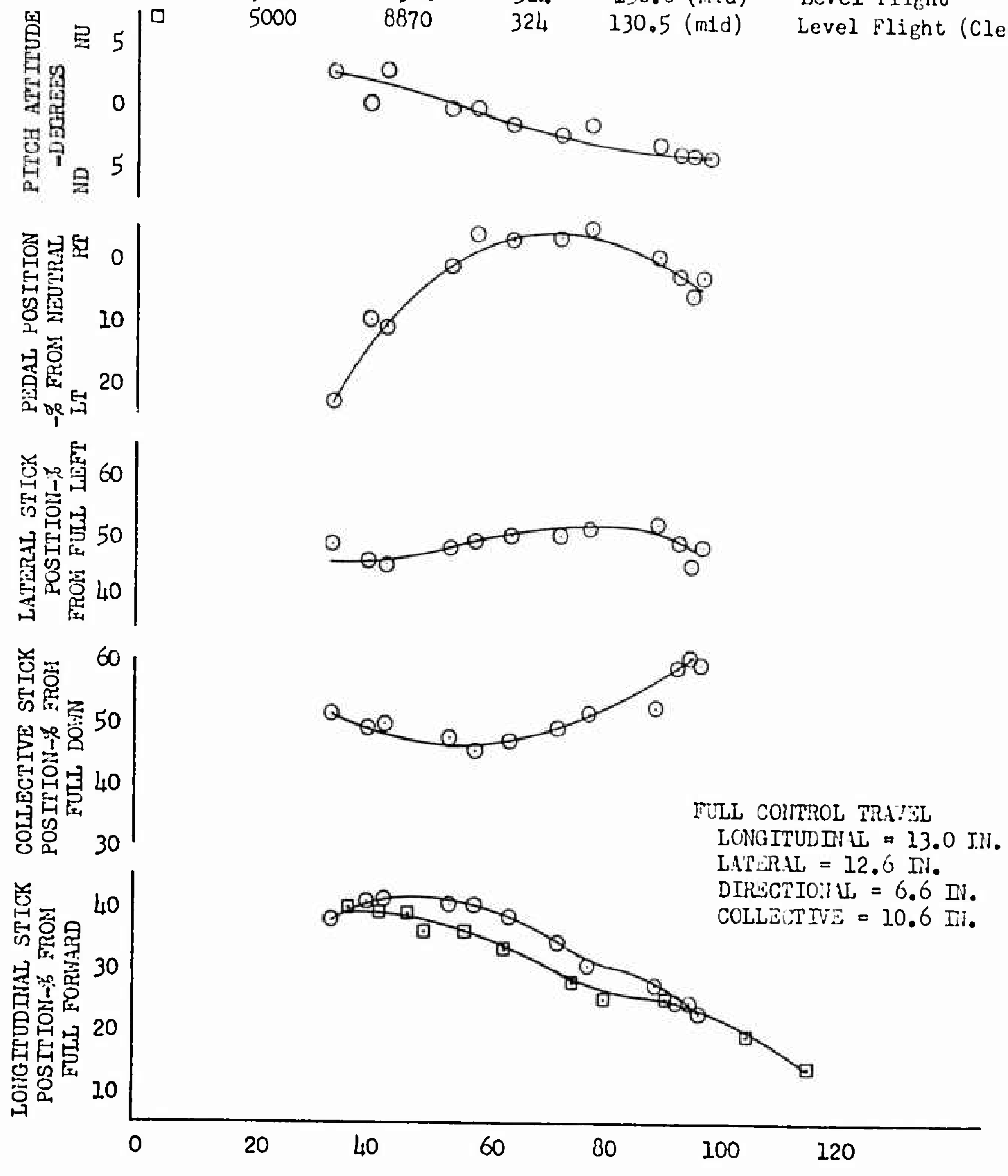


FIGURE NO. 20
CONTROL POSITION TRIM CURVES
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION

SYM	DENSITY ALTITUDE FT.	GROSS WEIGHT LB.	ROTOR SPEED RPM	C.G. LOCATION STA	FLIGHT CONDITION
o	5120	8730	314	130.8 (mid)	Level Flight

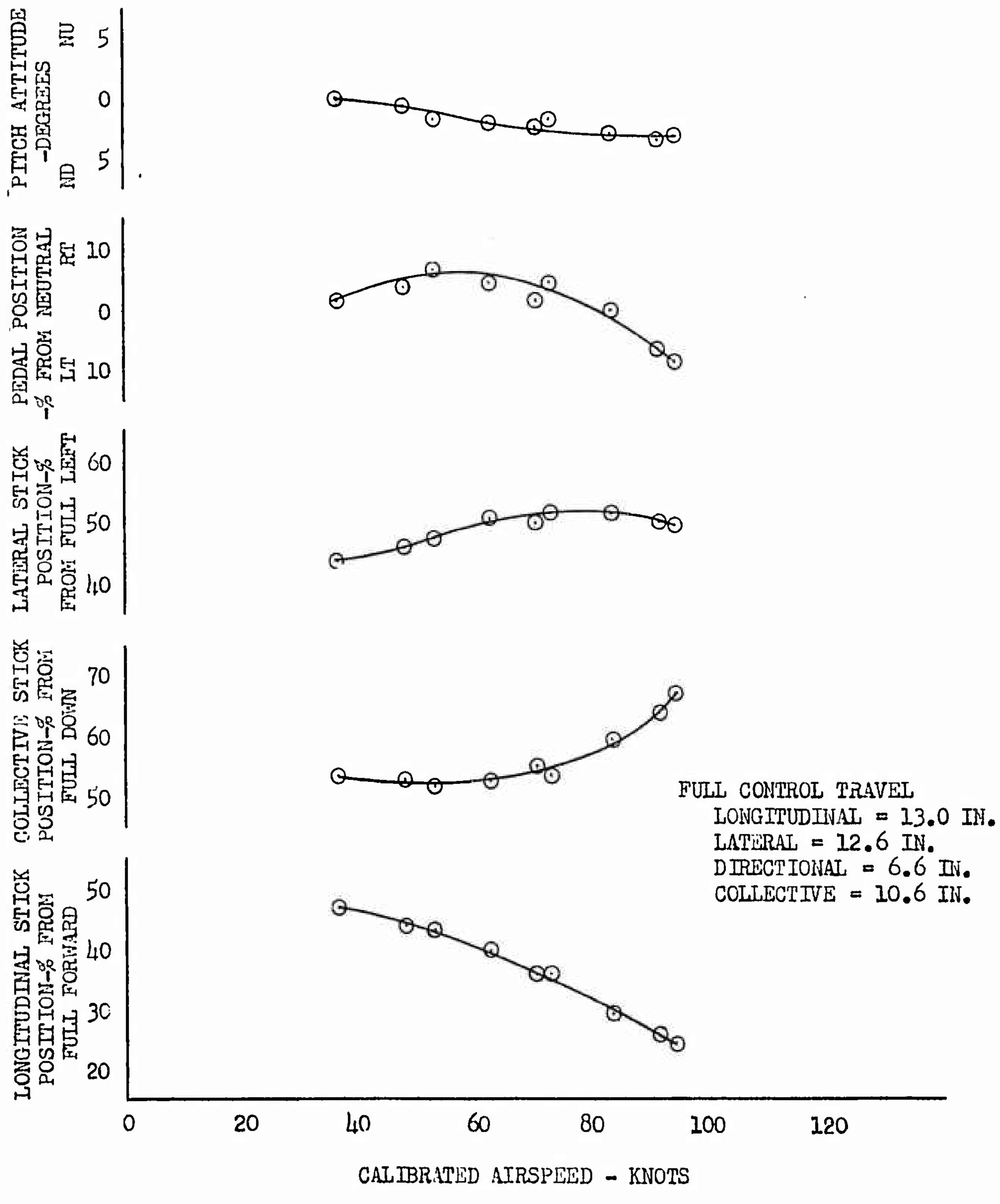


FIGURE NO. 21
CONTROL POSITION TRIM CURVES
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION

SYM	DENSITY ALTITUDE FT.	GROSS WEIGHT LB.	ROTOR SPEED RPM	C.G. LOCATION STA	FLIGHT CONDITION
o	3360	8190	324	134.0 (aft)	Level Flight

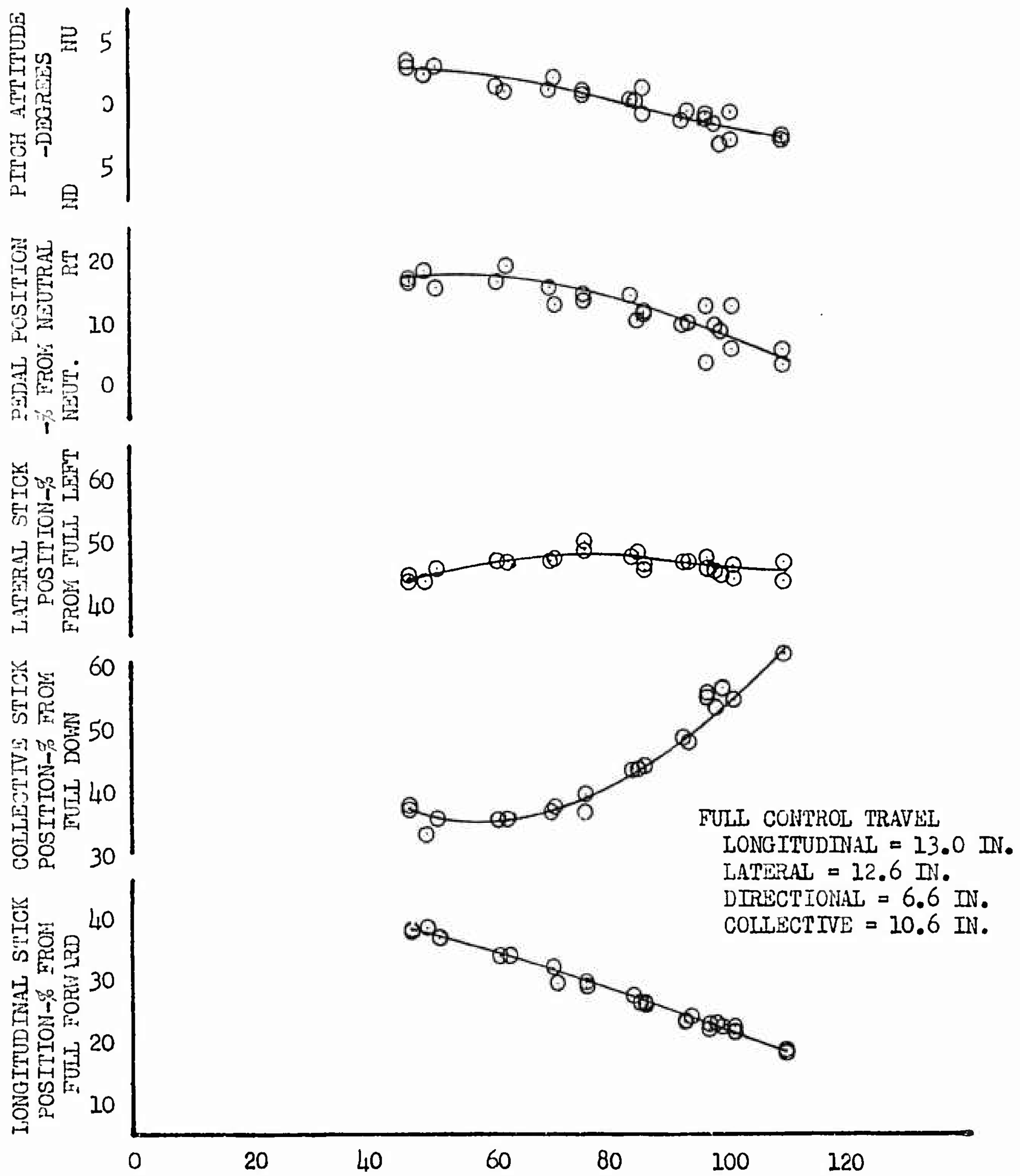


FIGURE NO. 22
CONTROL POSITIONS IN REARWARD FLIGHT
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION

SYM	DENSITY ALTITUDE FT.	GROSS WEIGHT LB.	ROTOR SPEED RPM	C.G. LOCATION STA
○	2940	8190	324	134.0 (aft)

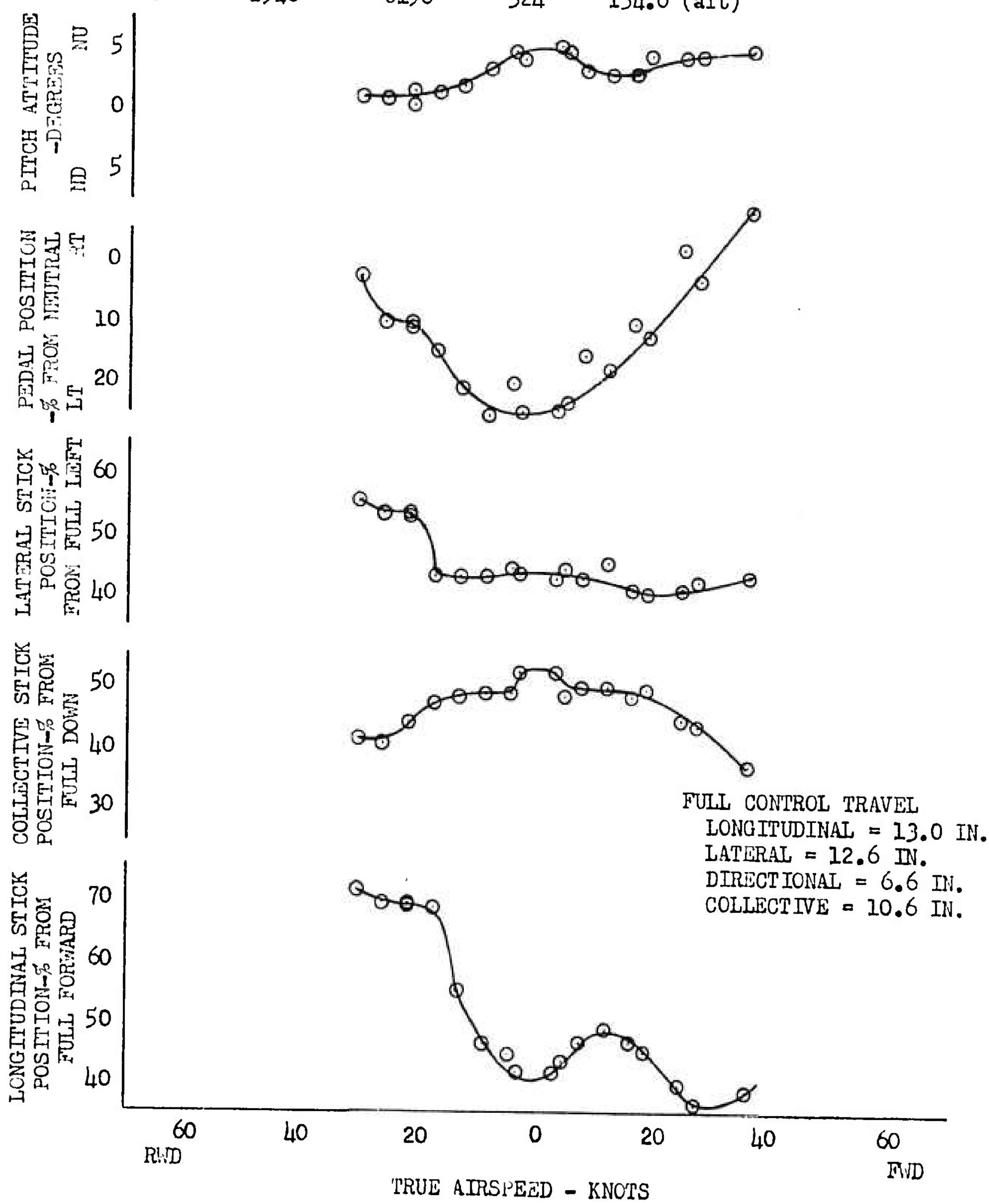


FIGURE NO. 23
CONTROL POSITIONS IN SIDEWARD FLIGHT
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION

SYM	DENSITY ALTITUDE FT.	GROSS WEIGHT LB.	ROTOR SPEED RPM	C.G. LOCATION STA
O	2940	8190	324	134.0 (aft)

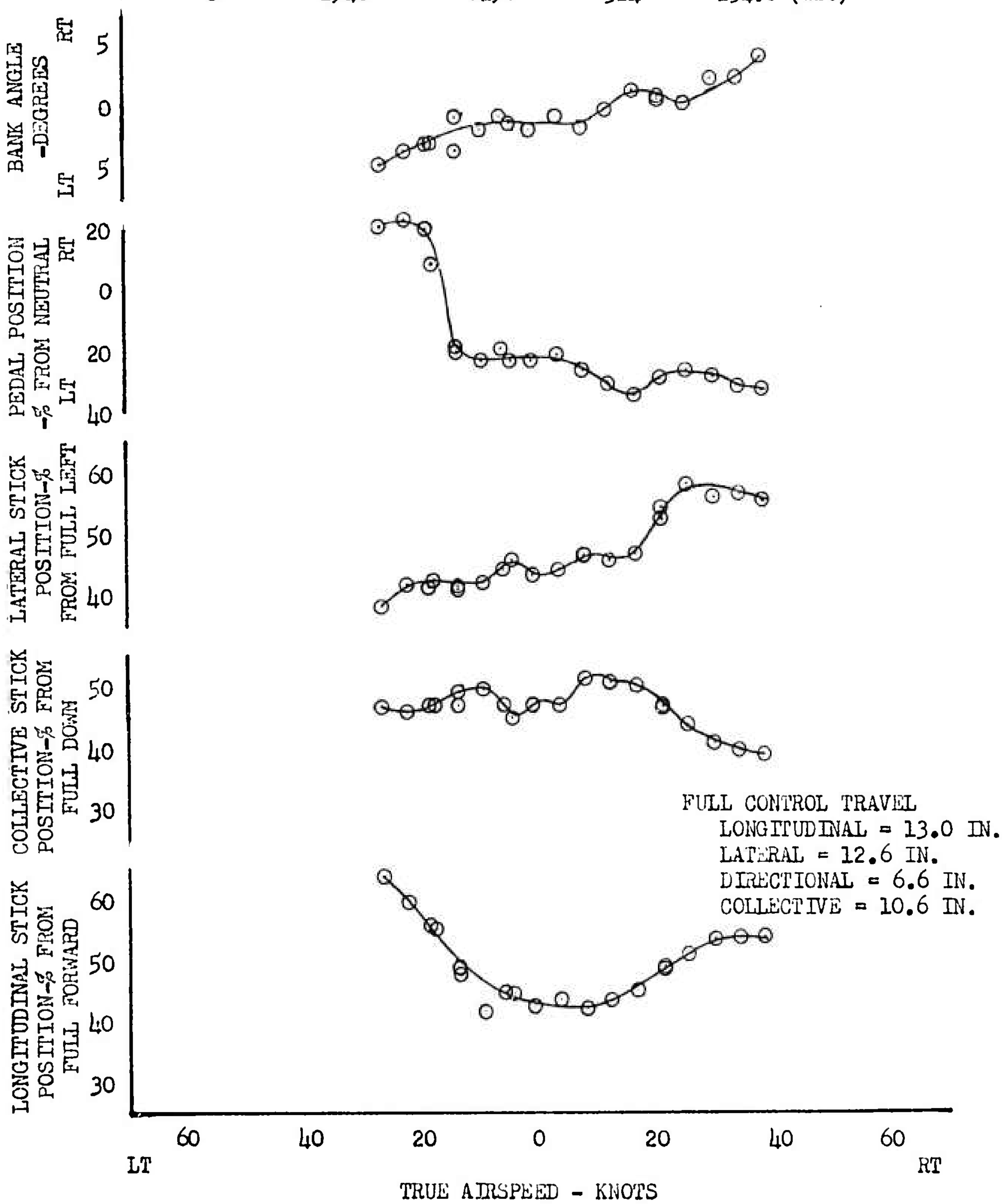
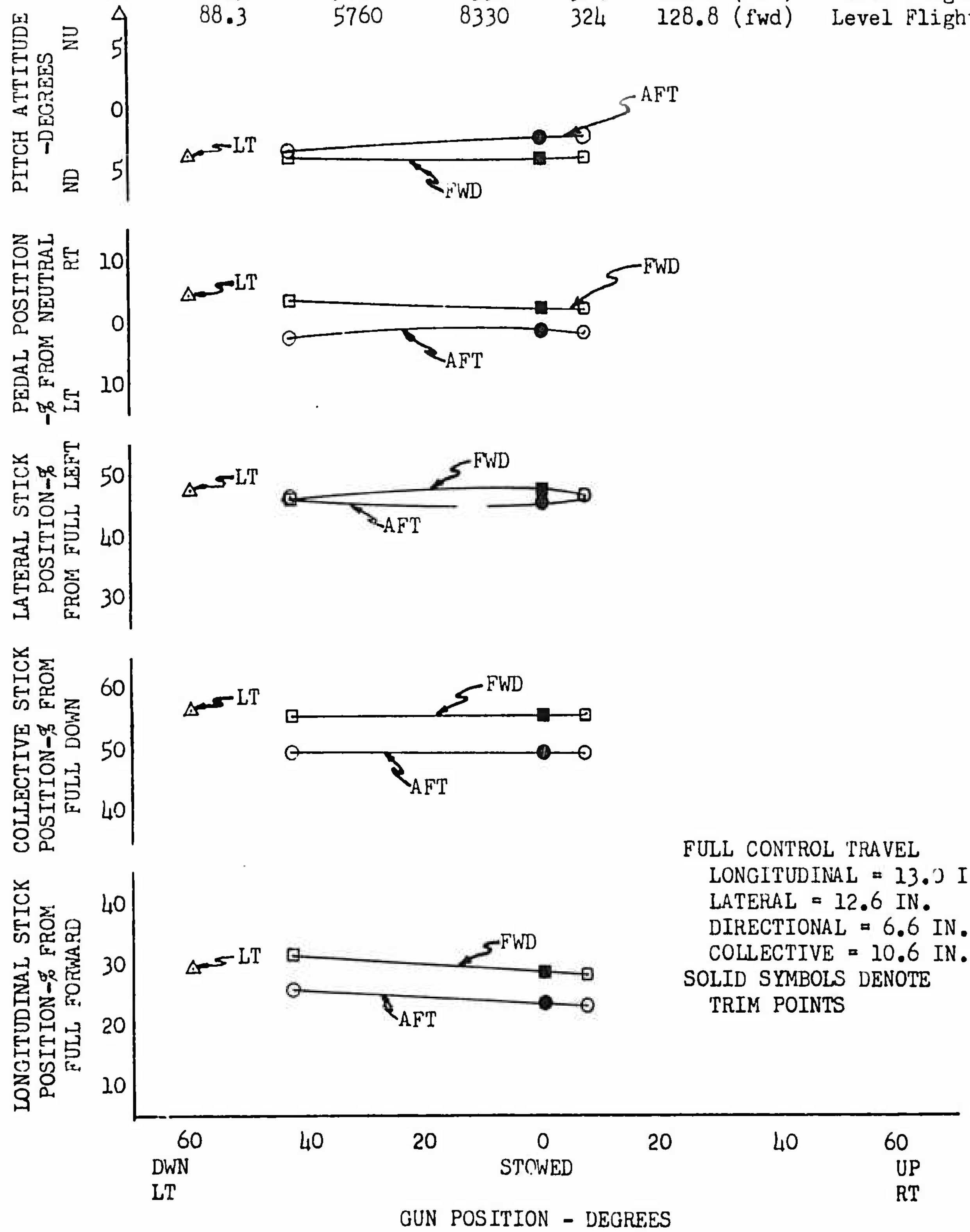


FIGURE NO. 24
CONTROL POSITION TRIM CURVES
UH-1C/XM-30 S/N 64-14102

SYM	TRIM AIRSPEED KTS.	DENSITY ALTITUDE FT.	GROSS WEIGHT LB.	ROTOR SPEED RPM	C.G. LOCATION STA	FLIGHT CONDITION
○	85.2	4760	8050	324	134.0 (aft)	Level Flight
□	88.3	5760	8330	324	128.8 (fwd)	Level Flight
△	88.3	5760	8330	324	128.8 (fwd)	Level Flight



FULL CONTROL TRAVEL
LONGITUDINAL = 13.0 IN.
LATERAL = 12.6 IN.
DIRECTIONAL = 6.6 IN.
COLLECTIVE = 10.6 IN.
SOLID SYMBOLS DENOTE TRIM POINTS

FIGURE NO. 25
STATIC LONGITUDINAL COLLECTIVE FIXED STABILITY
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION

SYM	TRIM AIRSPEED KTS.	DENSITY ALTITUDE FT.	GROSS WEIGHT LB.	ROTOR SPEED RPM	C.G. LOCATION STA	FLIGHT CONDITION
○	56.0	4940	8490	324	128.8 (fwd)	Level Flight
□	86.3	5590	8420	324	128.8 (fwd)	Level Flight

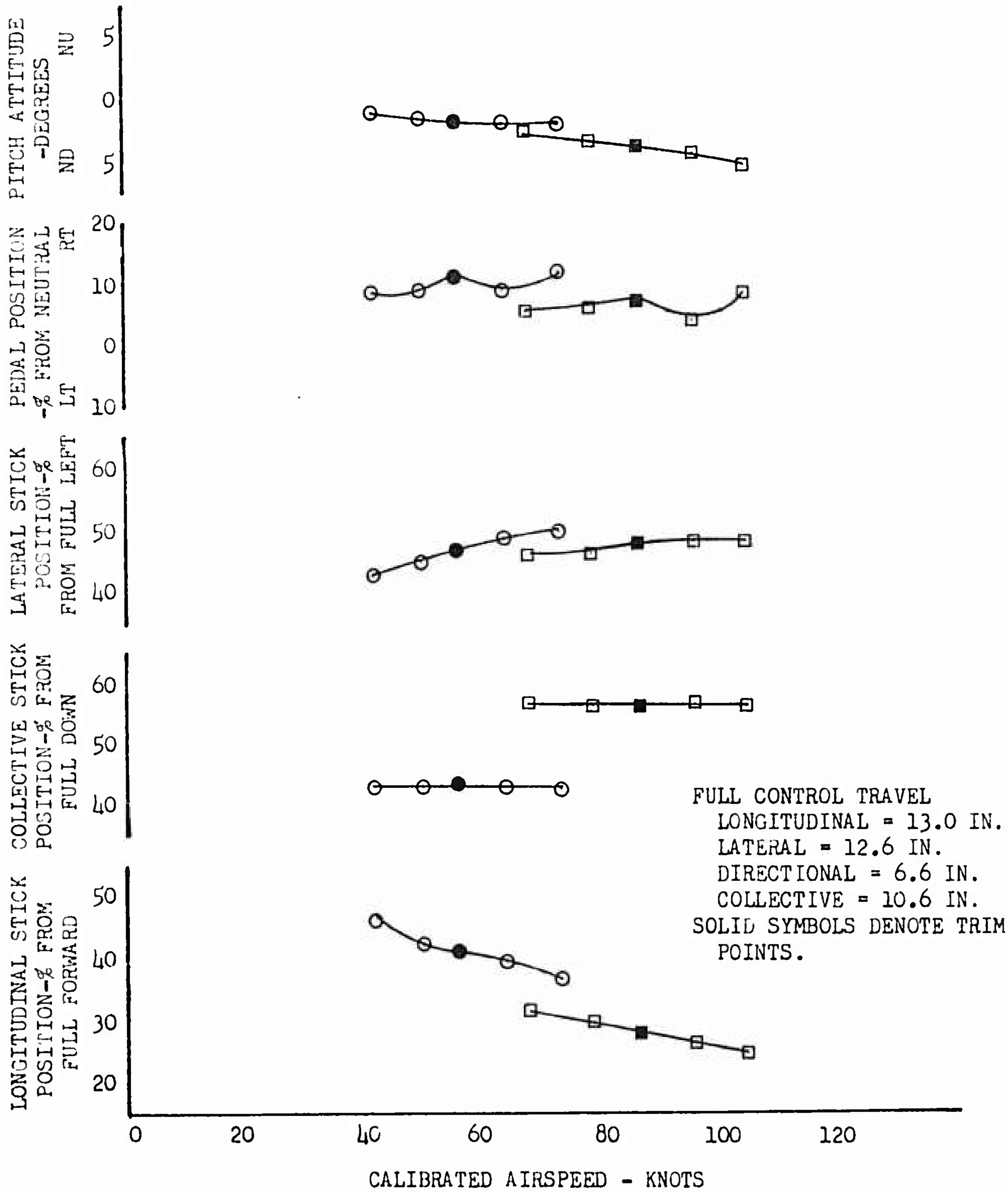


FIGURE NO. 26
STATIC LONGITUDINAL COLLECTIVE FIXED STABILITY
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION

SYM	TRIM AIRSPEED KTS.	DENSITY ALTITUDE FT.	GROSS WEIGHT LB.	ROTOR SPEED RPM	C.G. LOCATION STA	FLIGHT CONDITION
o	91.2	5600	8480	324	130.8 (mid)	Level Flight

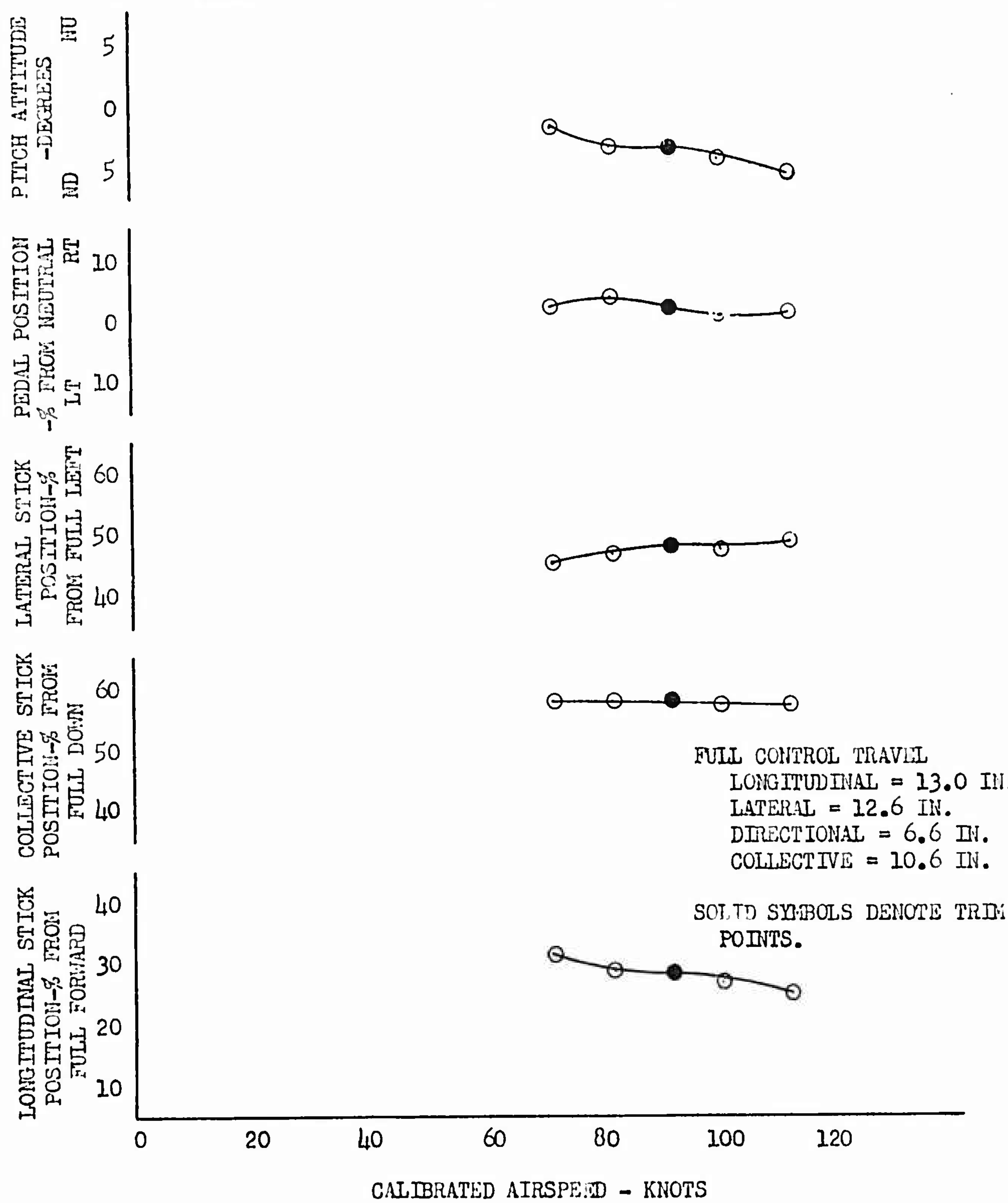
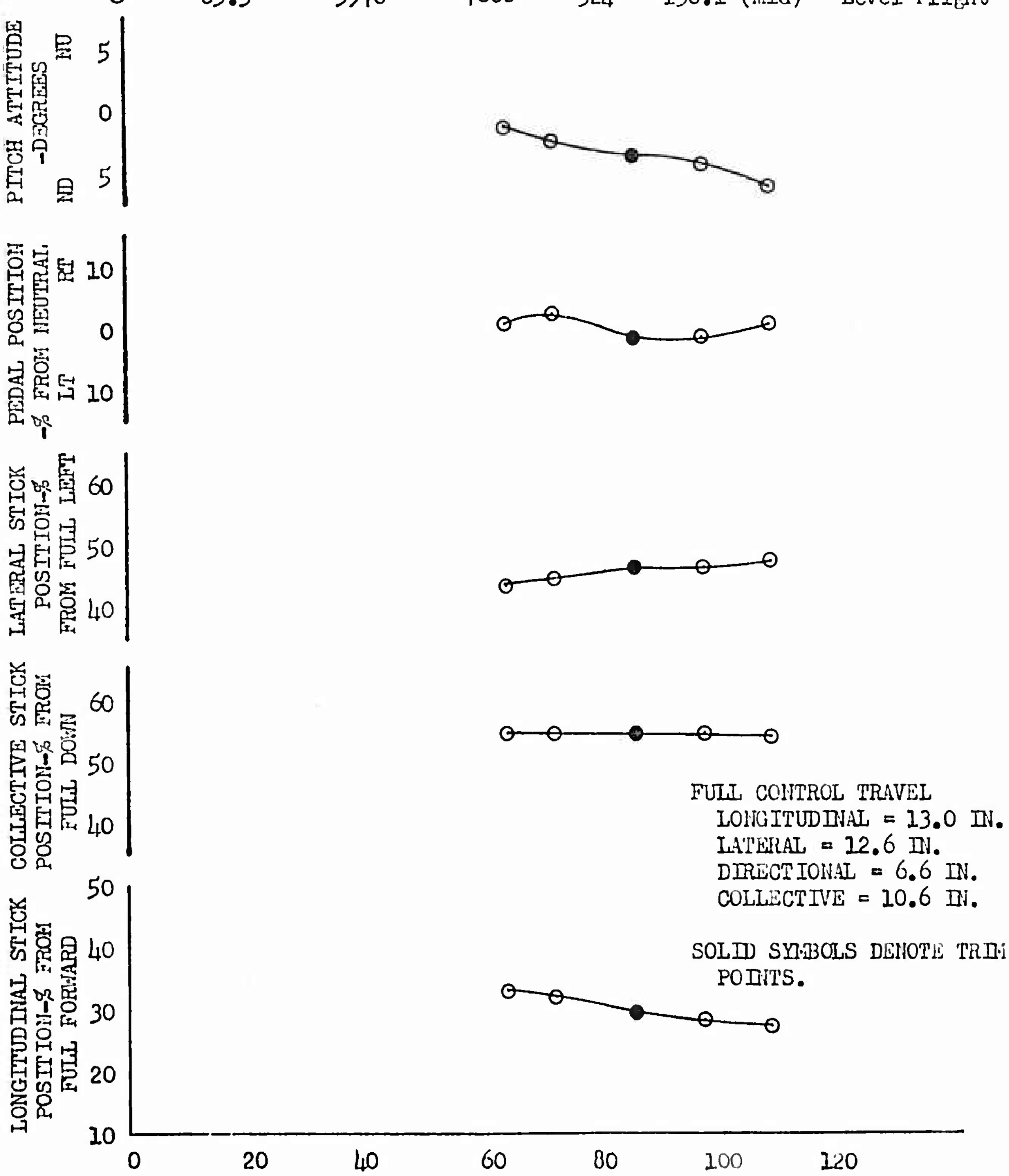


FIGURE NO. 27
STATIC LONGITUDINAL COLLECTIVE FIXED STABILITY
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION

SYM	TRIM AIRSPEED KTS.	DENSITY ALTITUDE FT.	GROSS WEIGHT LB.	ROTOR SPEED RPM	C.G. LOCATION STA	FLIGHT CONDITION
o	85.3	5970	7660	324	130.1 (mid)	Level Flight



CALIBRATED AIRSPEED - KNOTS

FIGURE NO. 28
STATIC LONGITUDINAL COLLECTIVE FIXED STABILITY
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION

SYM	TRIM AIRSPEED KTS.	DENSITY ALTITUDE FT.	GROSS WEIGHT LB.	ROTOR SPEED RPM	C.G. LOCATION STA	FLIGHT CONDITION
○	90.0	5370	8460	324	134.0 (aft)	Level Flight
□	58.5	5100	8213	324	134.0 (aft)	Level Flight

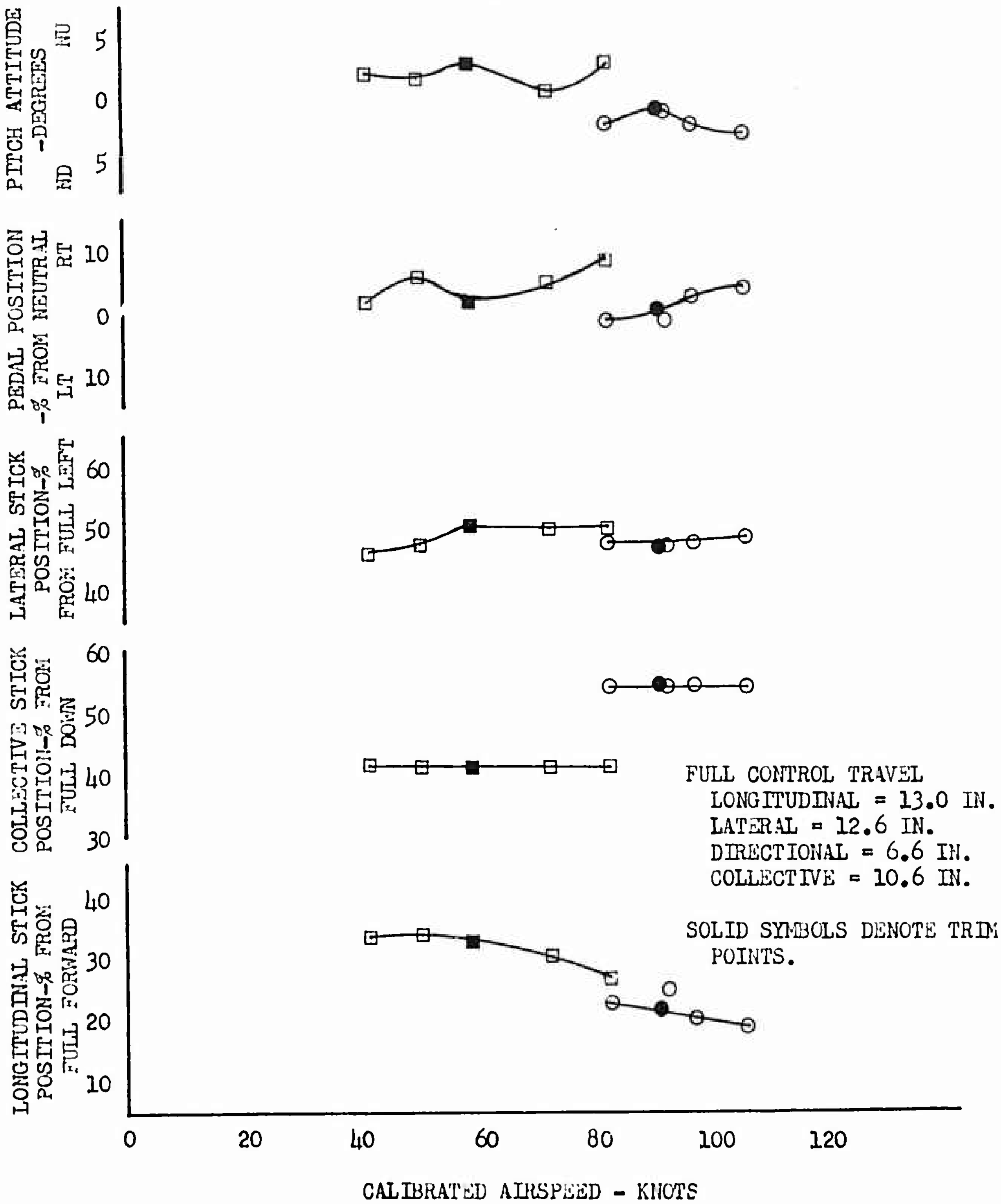


FIGURE NO. 29
STATIC LONGITUDINAL COLLECTIVE FIXED STABILITY
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION

SYM	TRIM AIRSPEED KTS.	DENSITY ALTITUDE FT.	GROSS WEIGHT LB.	ROTOR SPEED RPM	C.G. LOCATION STA	FLIGHT CONDITION
○	90.3	5350	8490	314	134.1 (aft)	Level Flight
□	56.0	5290	8490	314	134.1 (aft)	Level Flight

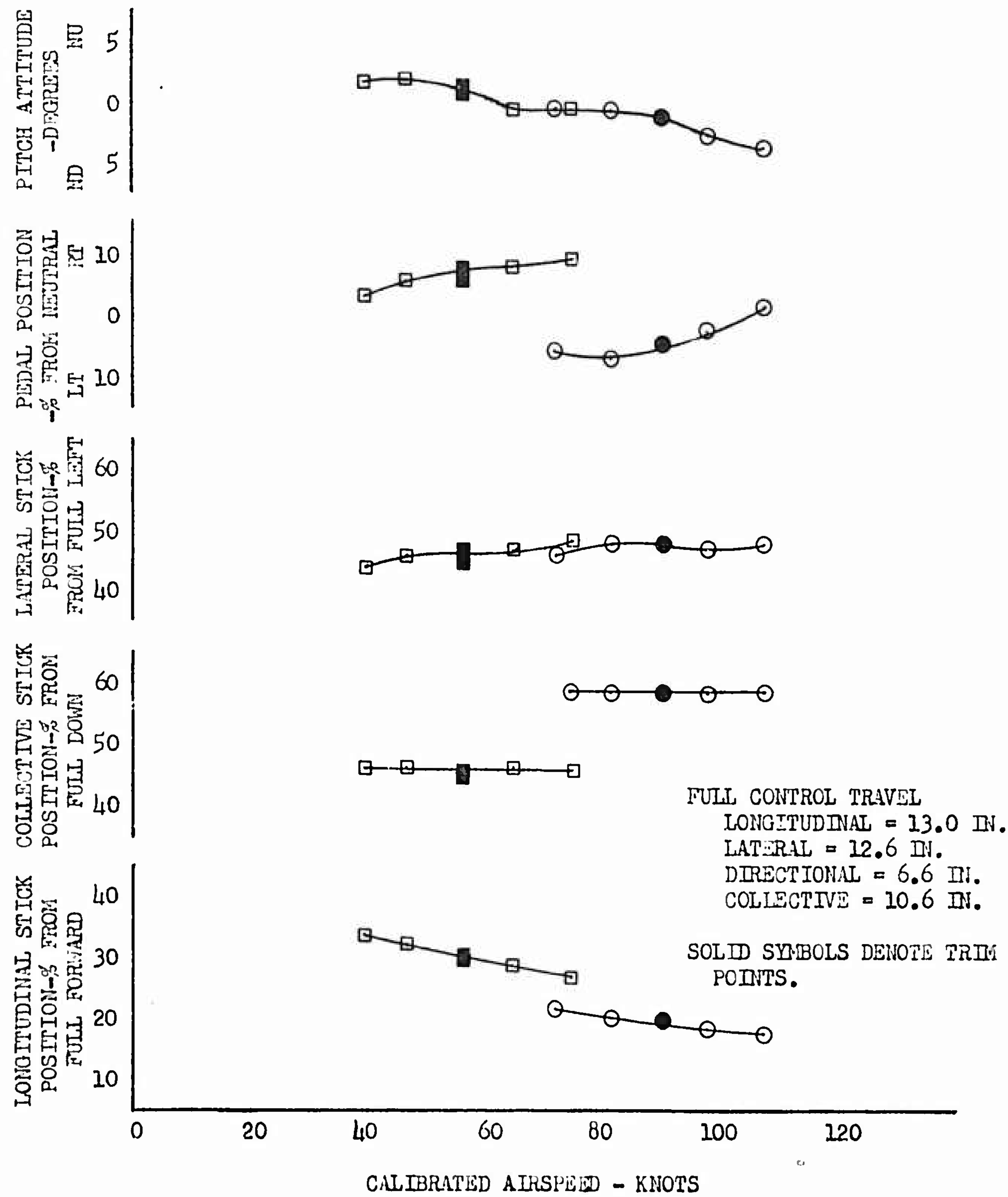


FIGURE NO. 30
STATIC LONGITUDINAL COLLECTIVE FIXED STABILITY
UH-1C/XM-30 S/N 64-14102
XM-30 IN STOWED POSITION

SYM	TRIM AIRSPEED KTS.	DENSITY ALTITUDE FT.	GROSS WEIGHT LB.	ROTOR SPEED RPM	C.G. LOCATION STA	FLIGHT CONDITION
○	54.2	3280	8920	324	130.1 (mid)	Climb
□	54.2	4280	8400	324	130.1 (mid)	Autorotation

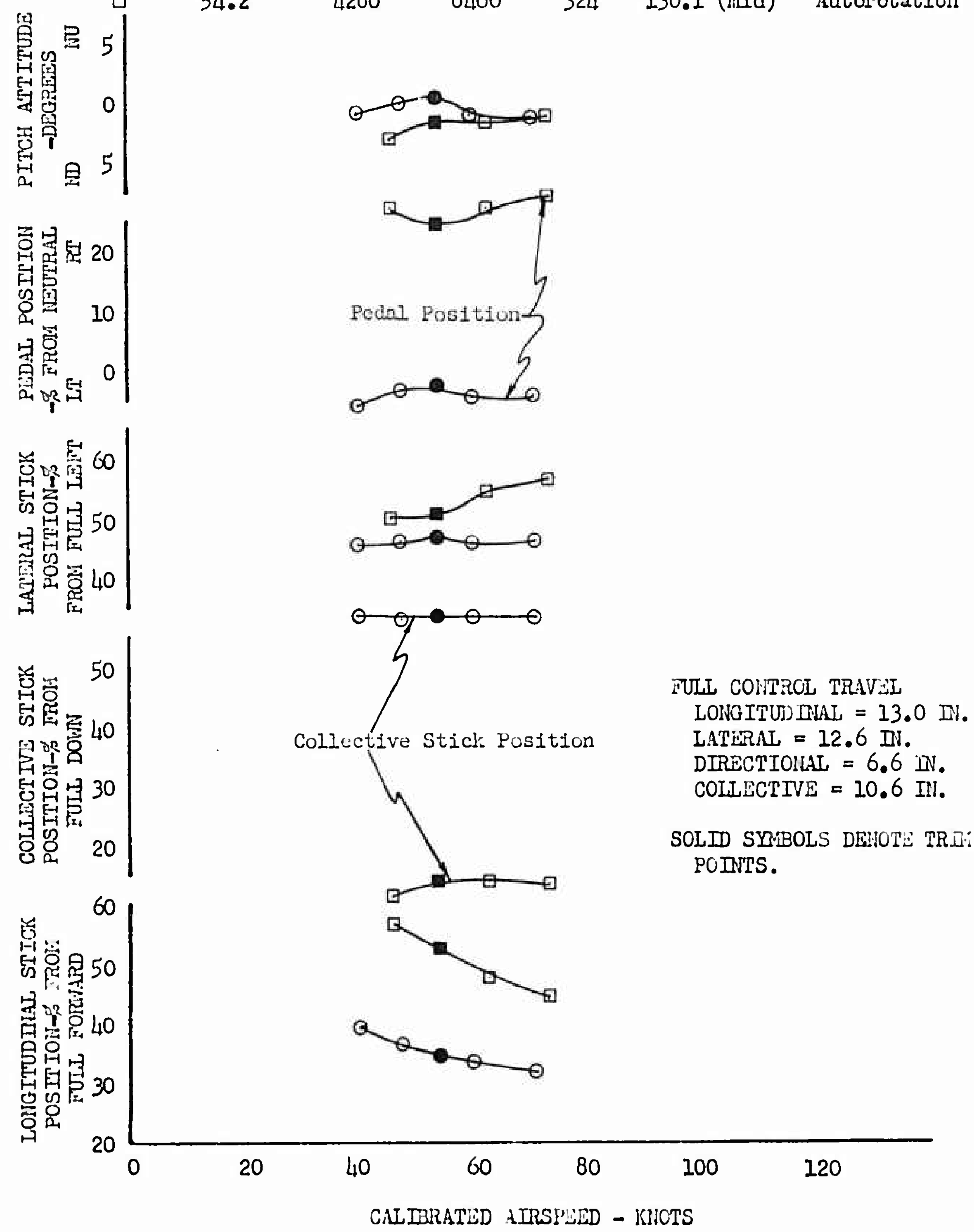


FIGURE NO. 31
STATIC LONGITUDINAL COLLECTIVE FIXED STABILITY
UH-30/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION

SYM	TRIM AIRSPEED KTS.	DENSITY ALTITUDE FT.	GROSS WEIGHT LB.	ROTOR SPEED RPM	C.G. LOCATION STA	FLIGHT CONDITION
O	87.2	4760	8050	324	134.0 (aft)	Max. Power Climb

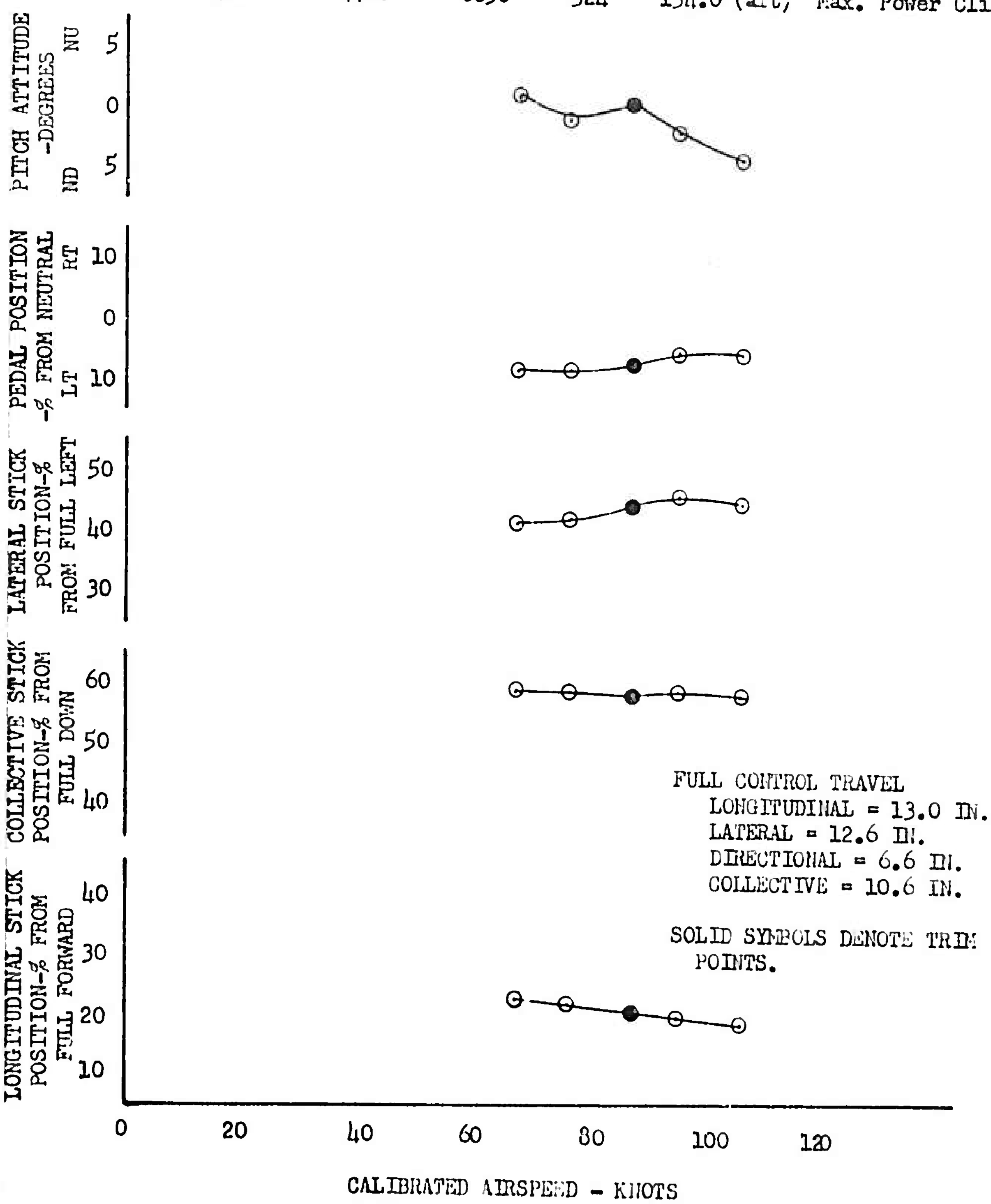


FIGURE NO. 32
STATIC LATERAL DIRECTIONAL STABILITY
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION

SYM	TRIM AIRSPEED KCAS	DENSITY ALTITUDE FT.	GROSS WEIGHT LB.	ROTOR SPEED RPM	C.G. LOCATION STA	FLIGHT CONDITION
○	54.5	5390	8290	324	134.1 (aft)	Level Flight
□	89.5	5880	8290	324	134.1 (aft)	Level Flight

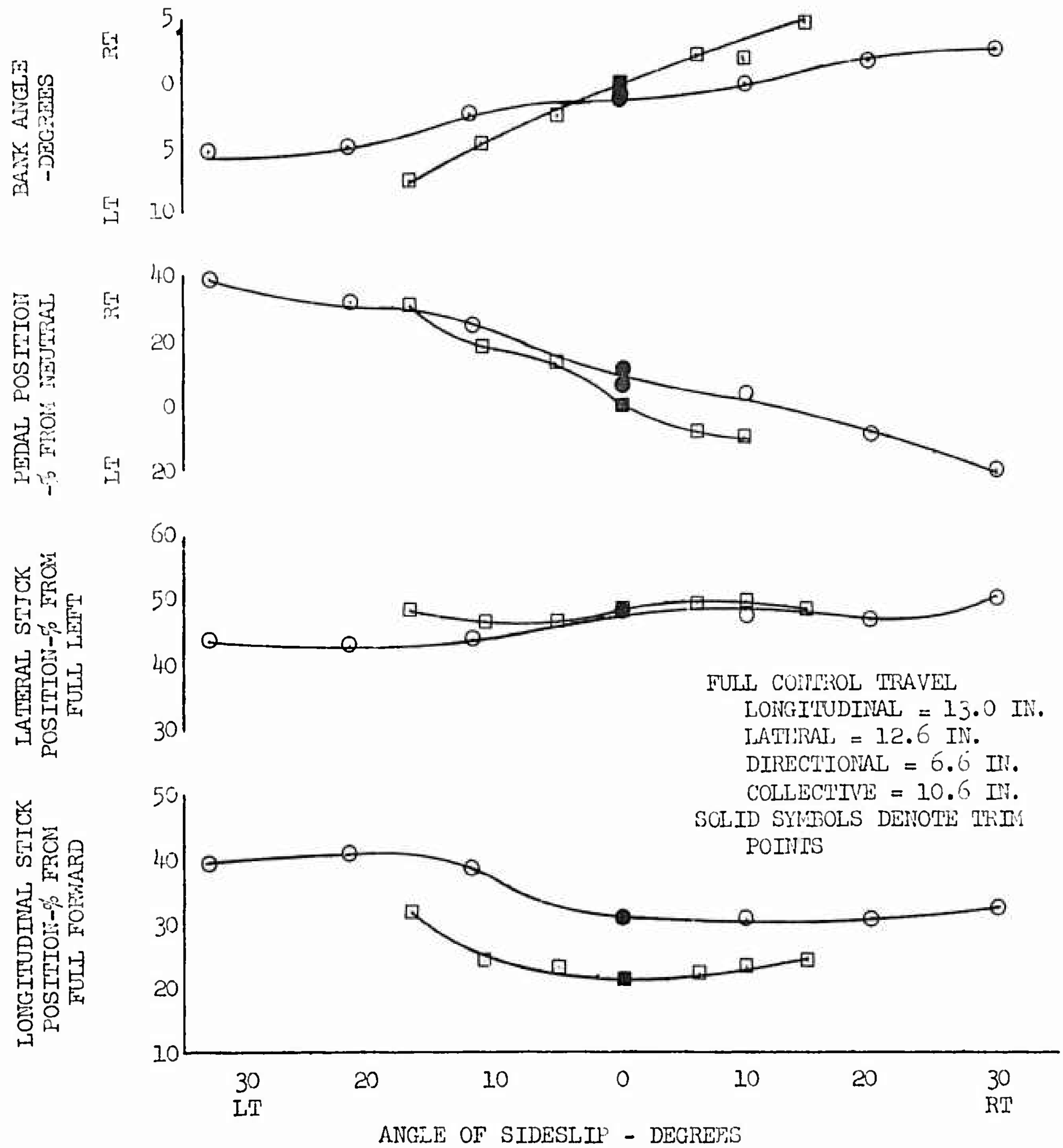


FIGURE NO. 36
LONGITUDINAL CONTROL SENSITIVITY
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION
LEVEL FLIGHT

SYM	CALIBRATED AIRSPEED KTS.	DENSITY ALTITUDE FT.	GROSS WEIGHT LB.	ROTOR SPEED RPM	C.G. LOCATION STA
○	91.0	5470	8320	324	134.0 (aft)

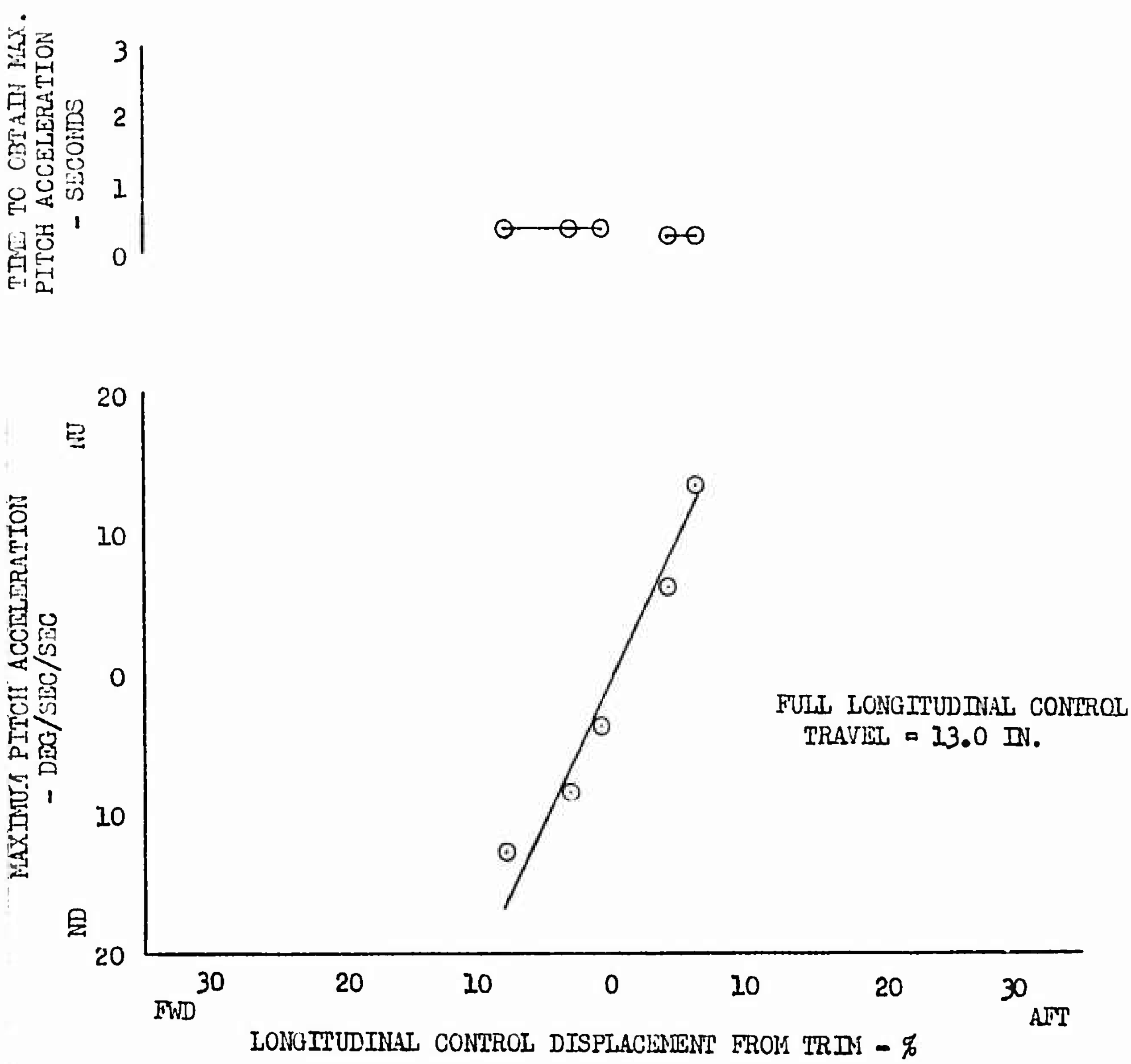


FIGURE NO. 37
LONGITUDINAL CONTROL RESPONSE
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION
LEVEL FLIGHT

SYM	CALIBRATED AIRSPEED KTS.	DENSITY ALTITUDE FT.	GROSS WEIGHT LB.	ROTOR SPEED RPM	C.G. LOCATION STA
○	91.0	5470	8320	324	134.0 (aft)

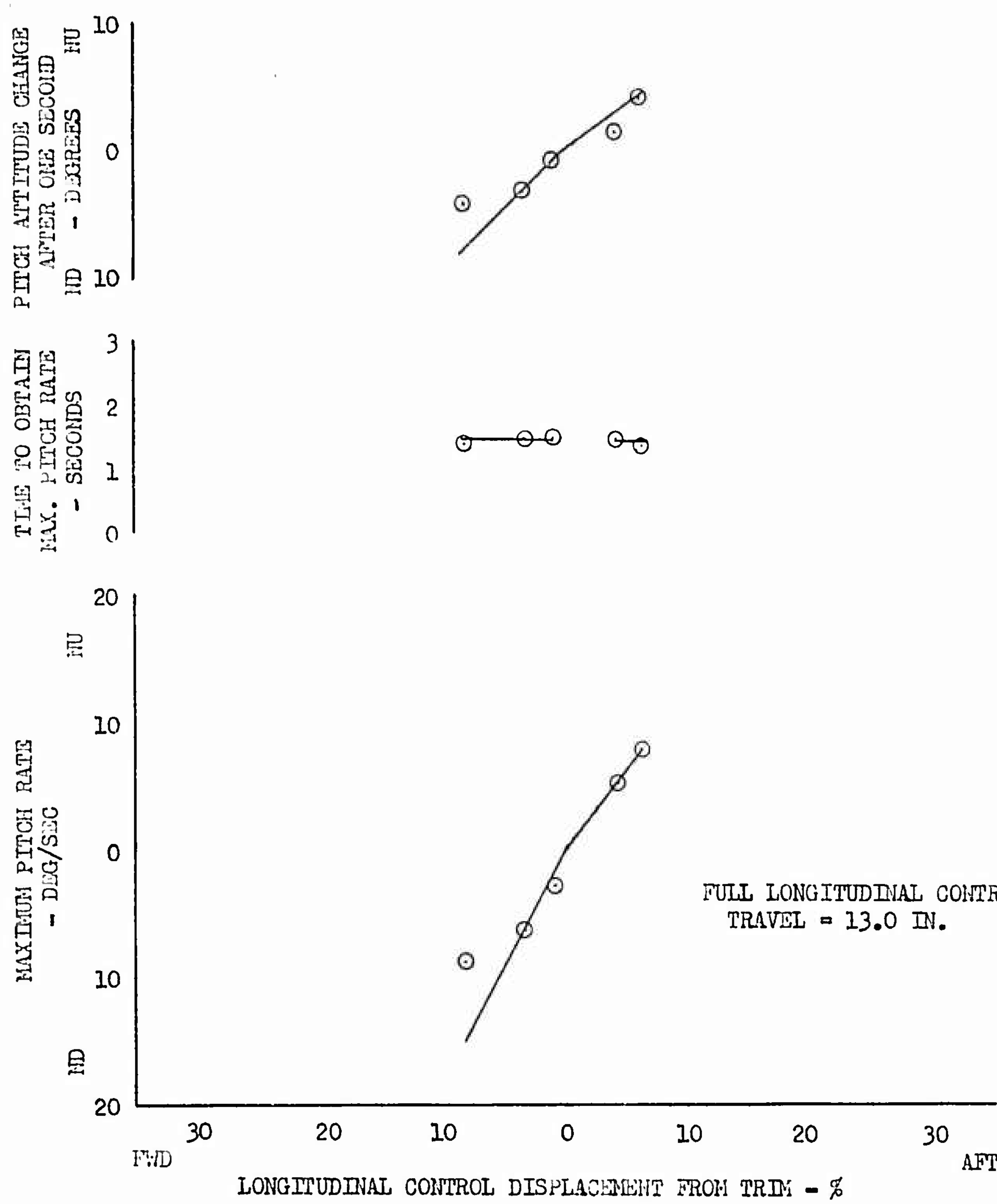


FIGURE NO. 38
LATERAL CONTROL SENSITIVITY
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION
LEVEL FLIGHT

SYM	CALIBRATED AIRSPEED KTS.	DENSITY ALTITUDE FT.	GROSS WEIGHT LB.	ROTOR SPEED RPM	C.G. LOCATION STA
o	91.0	5530	8240	324	134.0 (aft)

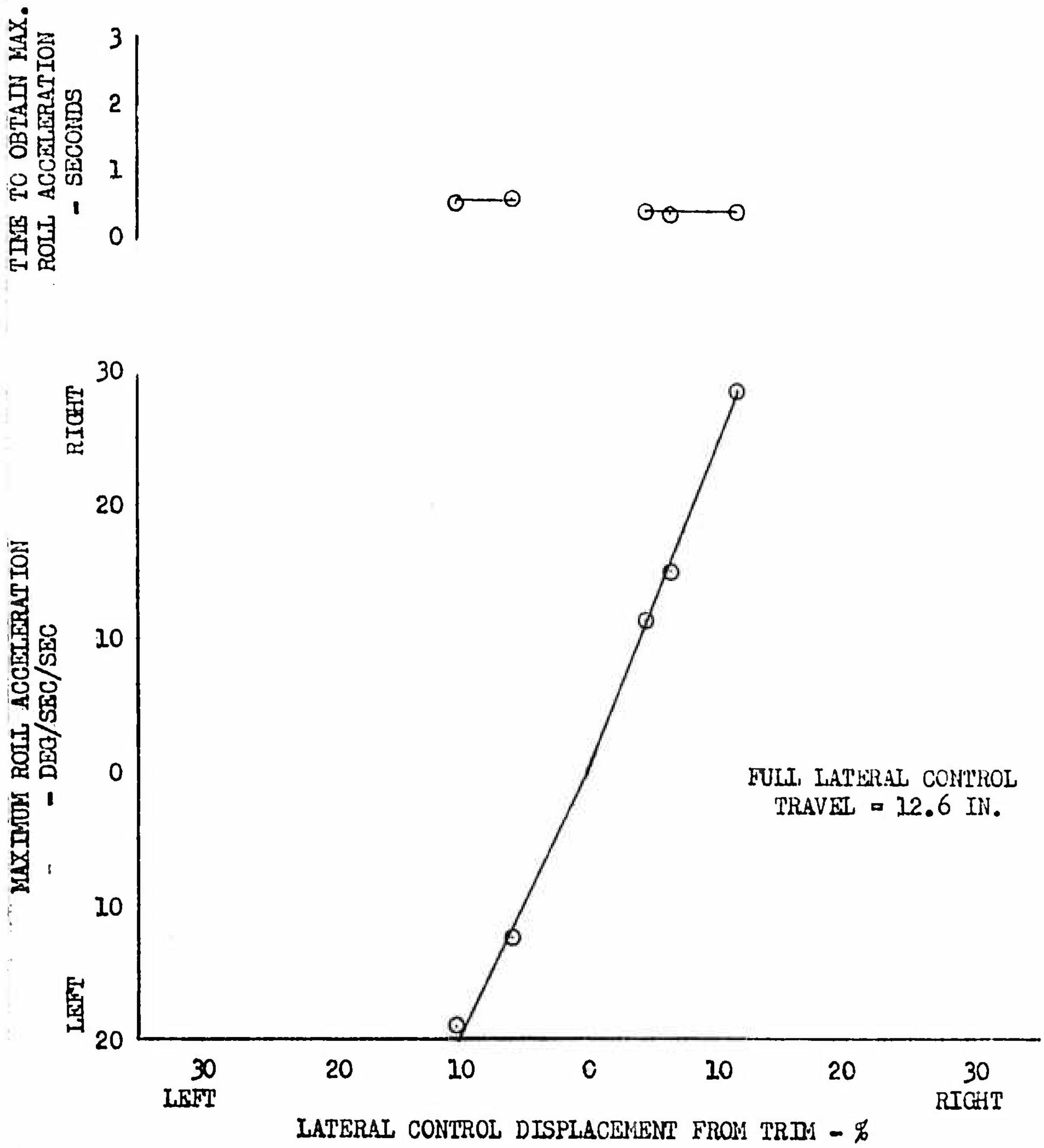


FIGURE NO. 39
LATERAL CONTROL RESPONSE
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION
LEVEL FLIGHT

SYM	CALIBRATED AIRSPEED KTS.	DENSITY ALTITUDE FT.	GROSS WEIGHT LB.	ROTOR SPEED RPM	C.G. LOCATION STA
○	91.0	5530	8240	324	134.0 (aft)

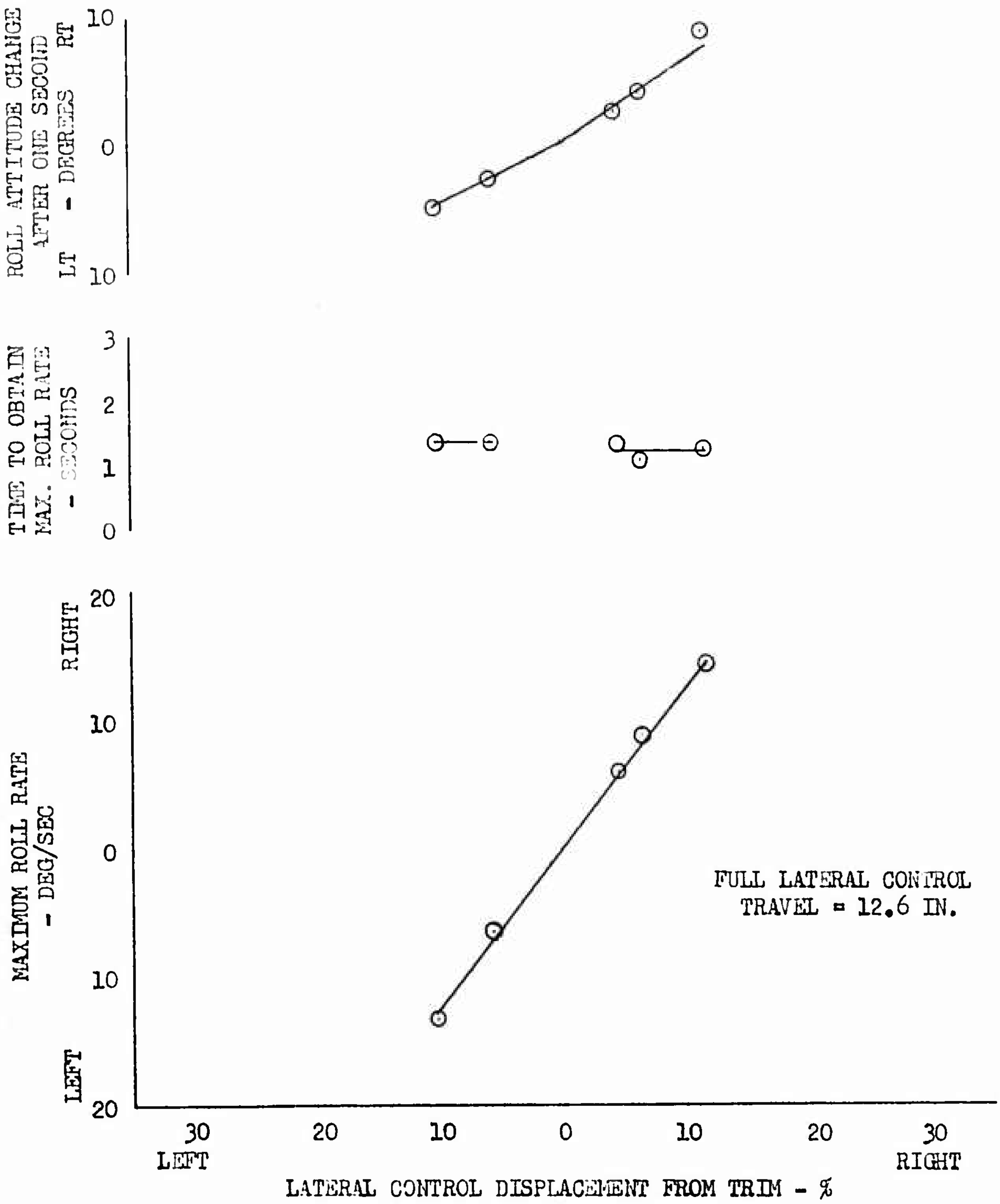


FIGURE NO. 40
DIRECTIONAL CONTROL SENSITIVITY
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION
LEVEL FLIGHT

SYM	CALIBRATED AIRSPEED KTS.	DENSITY ALTITUDE FT.	GROSS WEIGHT LB.	ROTOR SPEED RPM	C.G. LOCATION STA
○	91.0	5530	8200	324	134.0 (aft)

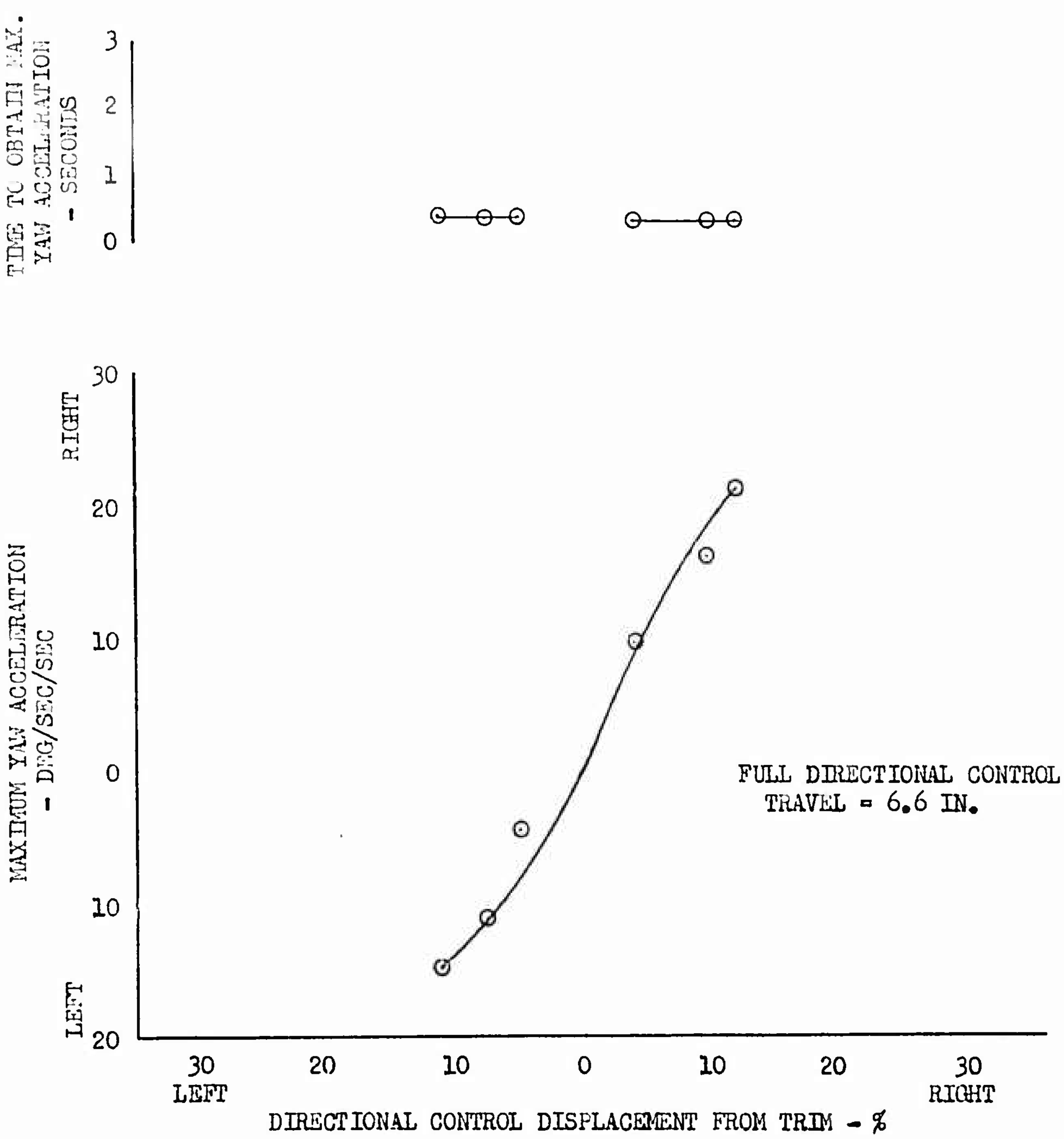


FIGURE NO. 41
DIRECTIONAL CONTROL RESPONSE
UH-1C/XM-30 S/N 64-14102

XM-30 IN STOWED POSITION
LEVEL FLIGHT

SYM	CALIBRATED AIRSPEED KTS.	DENSITY ALTITUDE FT.	GROSS WEIGHT LB.	ROTOR SPEED RPM	C.G. LOCATION STA
O	91.0	5530	8200	324	134.0 (aft)

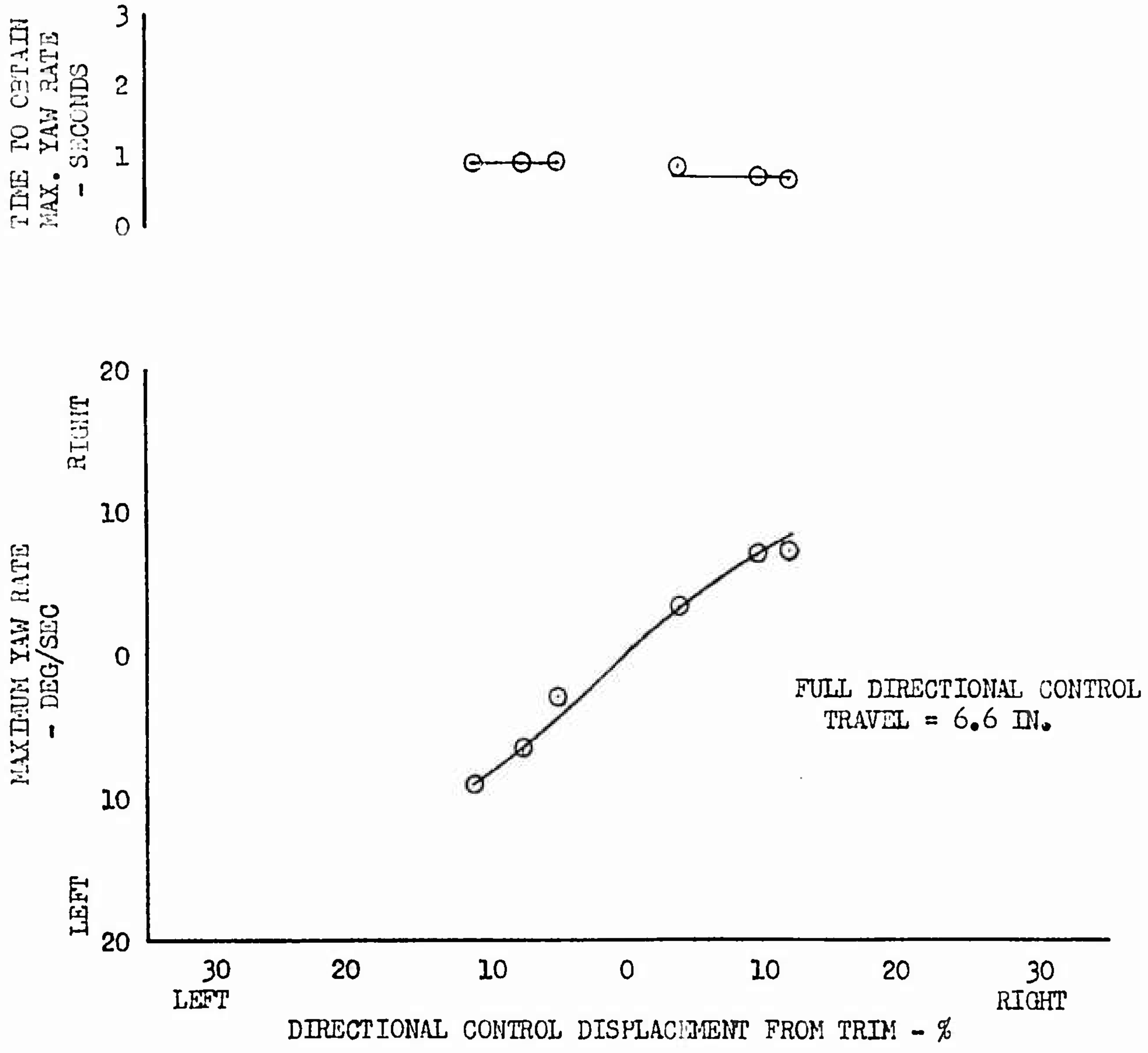


FIGURE NO. 49
RIGHT TURRET BRACE (SHORT) AXIAL FORCE DURING FIRING
UH-1C/XM-30 S/N 64-14102

LEVEL FLIGHT

DENSITY ALTITUDE: 5000 FT.
GROSS WEIGHT: 8000 LB.
ROTOR SPEED: 324 RPM
C.G. LOC: STA 128.1 (fwd)

SYM	CONFIGURATION
○	Guns elevated & firing
□	Guns stowed & firing
△	Guns depressed & firing
⌂	Guns transient & firing
◇	Guns elevated & traversed right, right gun firing

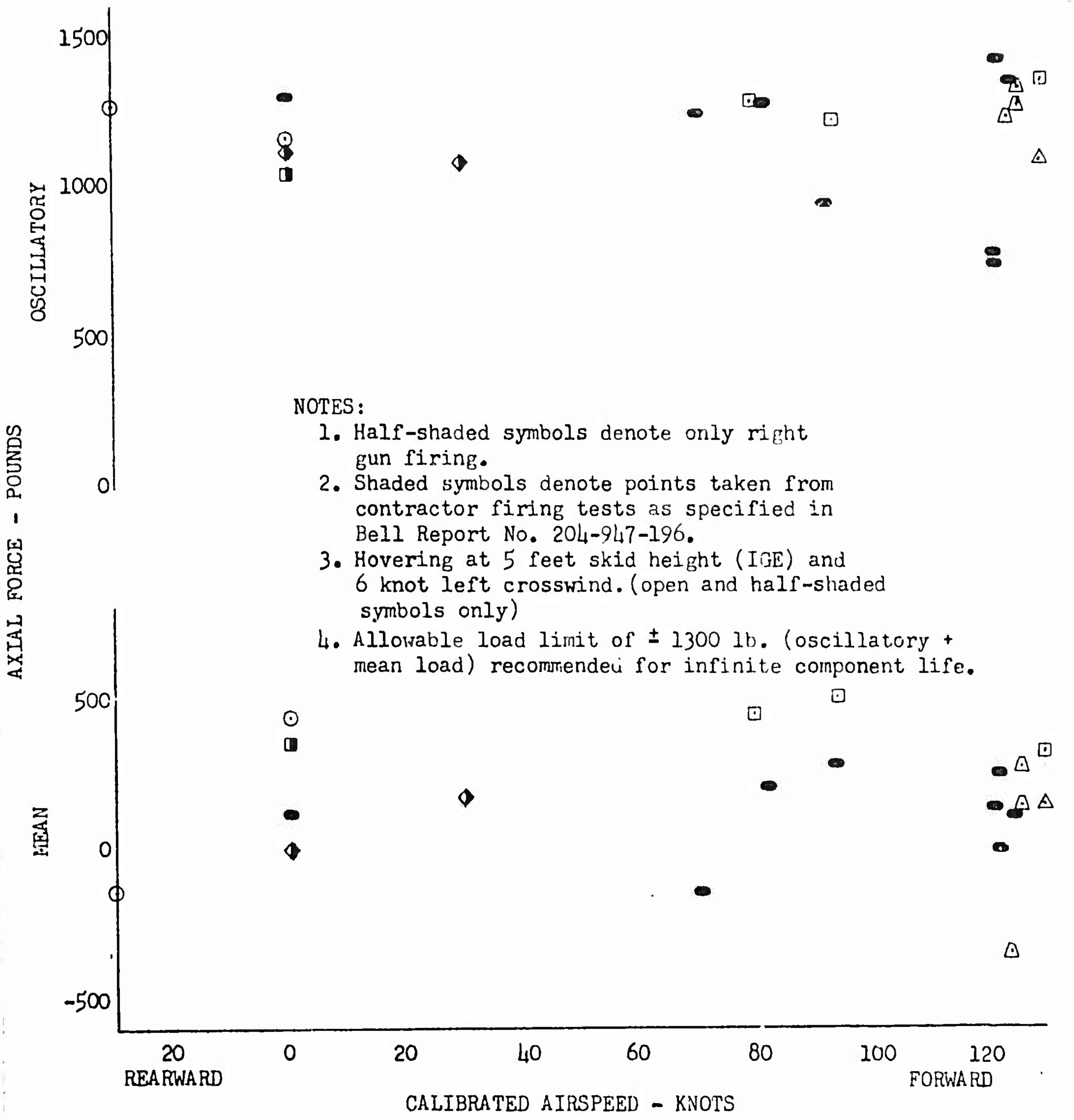


FIGURE NO. 50
LEFT TURRET BRACE (SHORT) AXIAL FORCE DURING FIRING
UH-1C/XM-30 S/N 64-14102

LEVEL FLIGHT

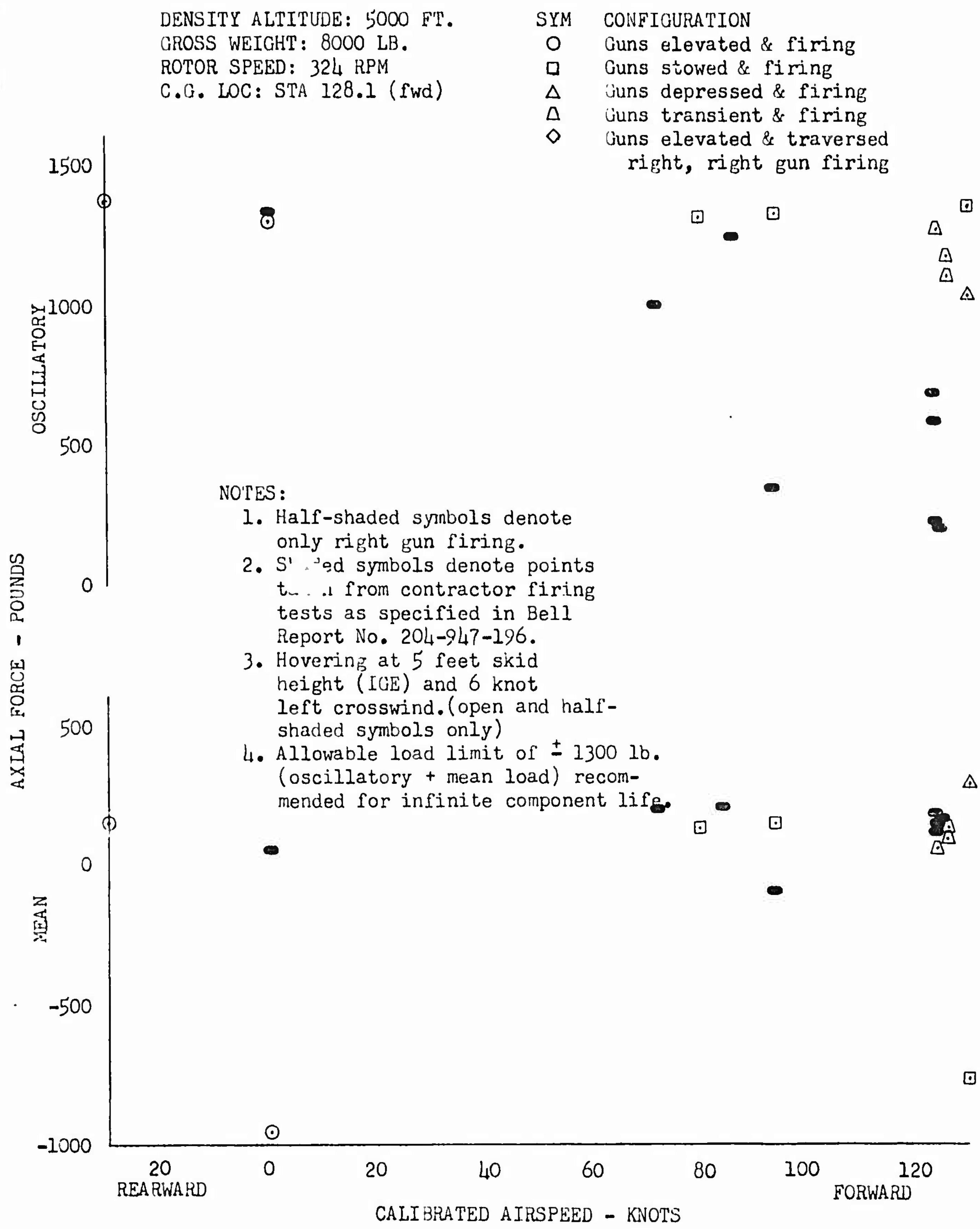


FIGURE NO. 51
TAIL ROTOR BLADE BEAM BENDING MOMENT DURING FIRING
UH-1C/XM-30 S/N 64-14102

LEVEL FLIGHT

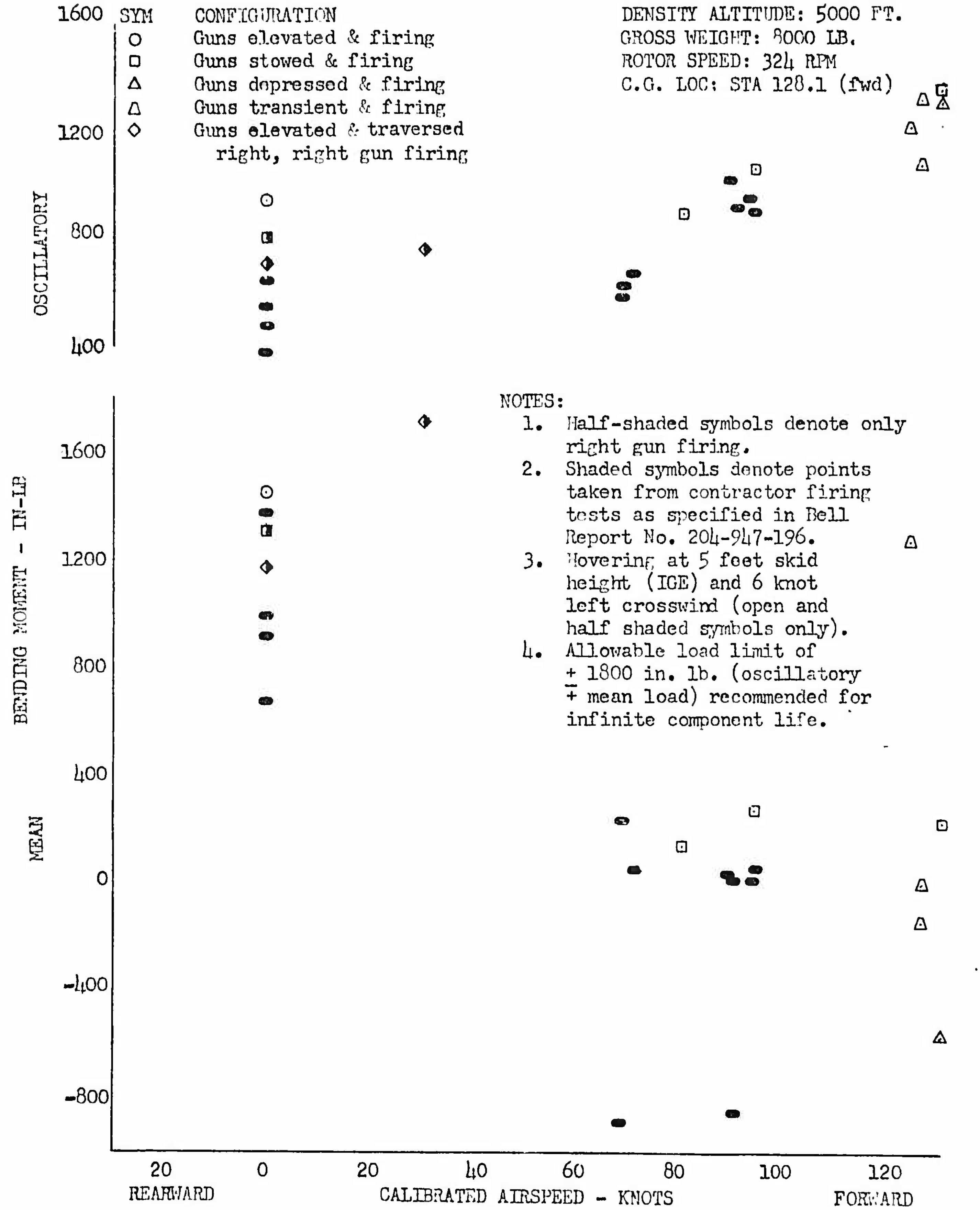


FIGURE NO. 52
TAIL ROTOR BLADE CHORD BENDING MOMENT DURING FIRING
UH-1C/XM-30 S/N 64-14102

LEVEL FLIGHT

DENSITY ALTITUDE: 5000 FT.
GROSS WEIGHT: 8000 LB.
ROTOR SPEED: 324 RPM
C.G. LOC: STA 128.1 (fwd)

SYM	CONFIGURATION
○	Guns elevated & firing
□	Guns stowed & firing
△	Guns depressed & firing
⏢	Guns transient & firing
◇	Guns elevated & traversed right, right gun firing

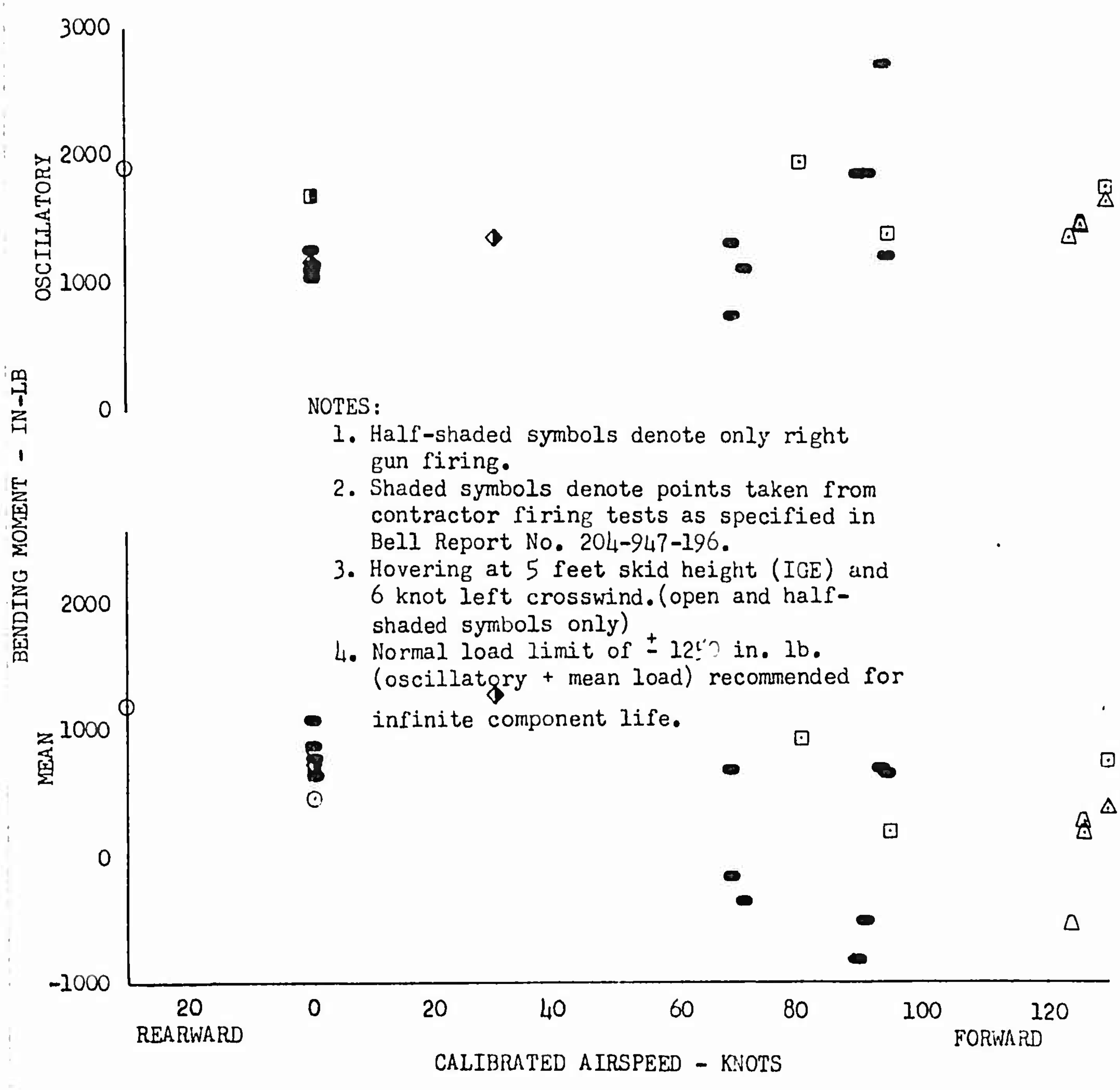


FIGURE NO. 53
TAIL BOOM LONGERON STRESS DURING FIRING
UH-1C/XM-30 S/N 64-14102

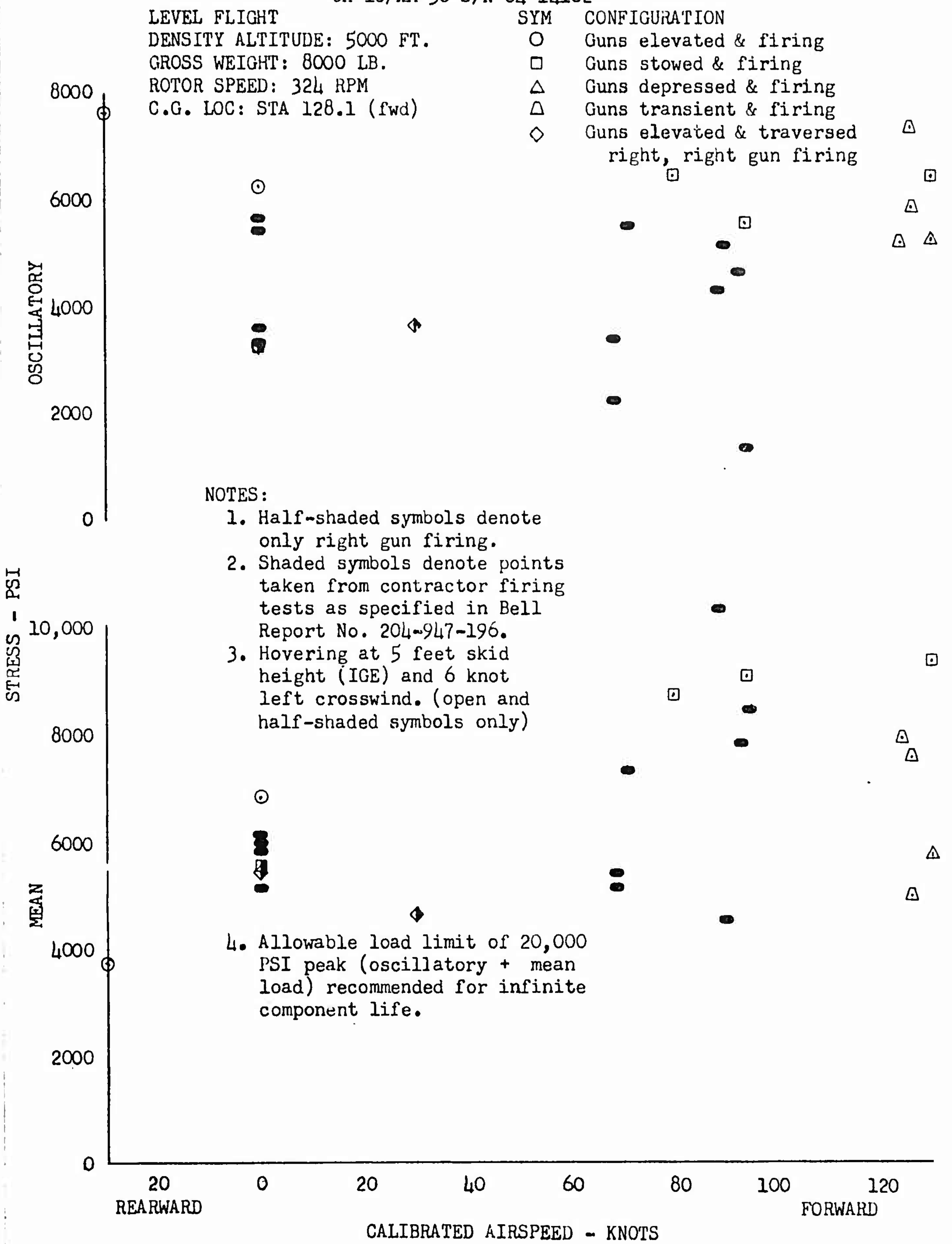
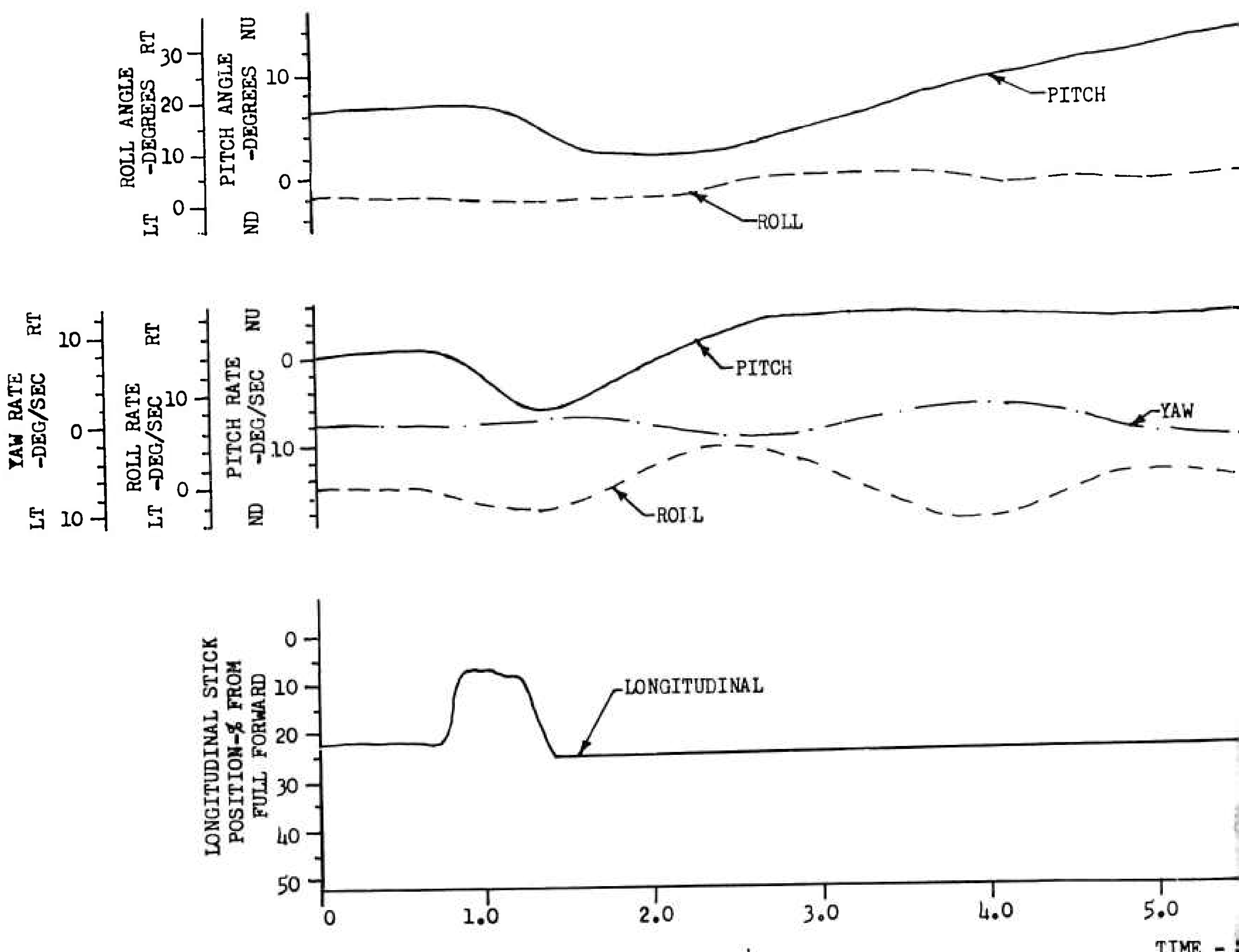


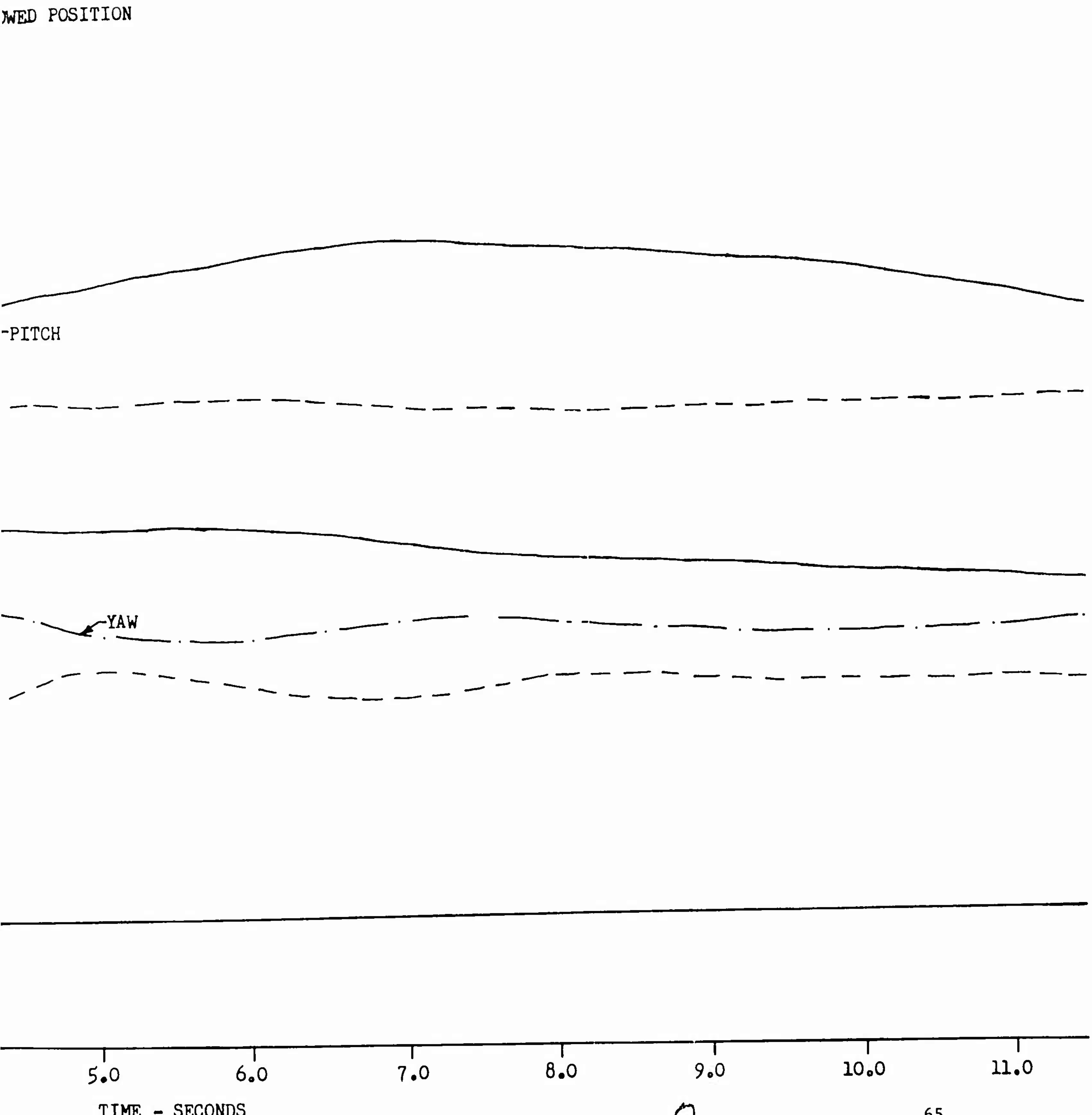
FIGURE NO. 33
FORWARD LONGITUDINAL PULSE
UH-1C/XM-30 S/N 64-14102
FLIGHT CONDITION: Level Flight
FULL LONGITUDINAL TRAVEL: 13.0 IN.

TRIM
DENSI
GROSS
ROTOR
C.G.

XM-30 IN STOWED POSITION



TRIM AIRSPEED: 91.0 KCAS
DENSITY ALTITUDE: 5530 FT.
GROSS WEIGHT: 8420 LB.
ROTOR SPEED: 324 RPM
C.G. LOCATION: STA 134.0 (aft)

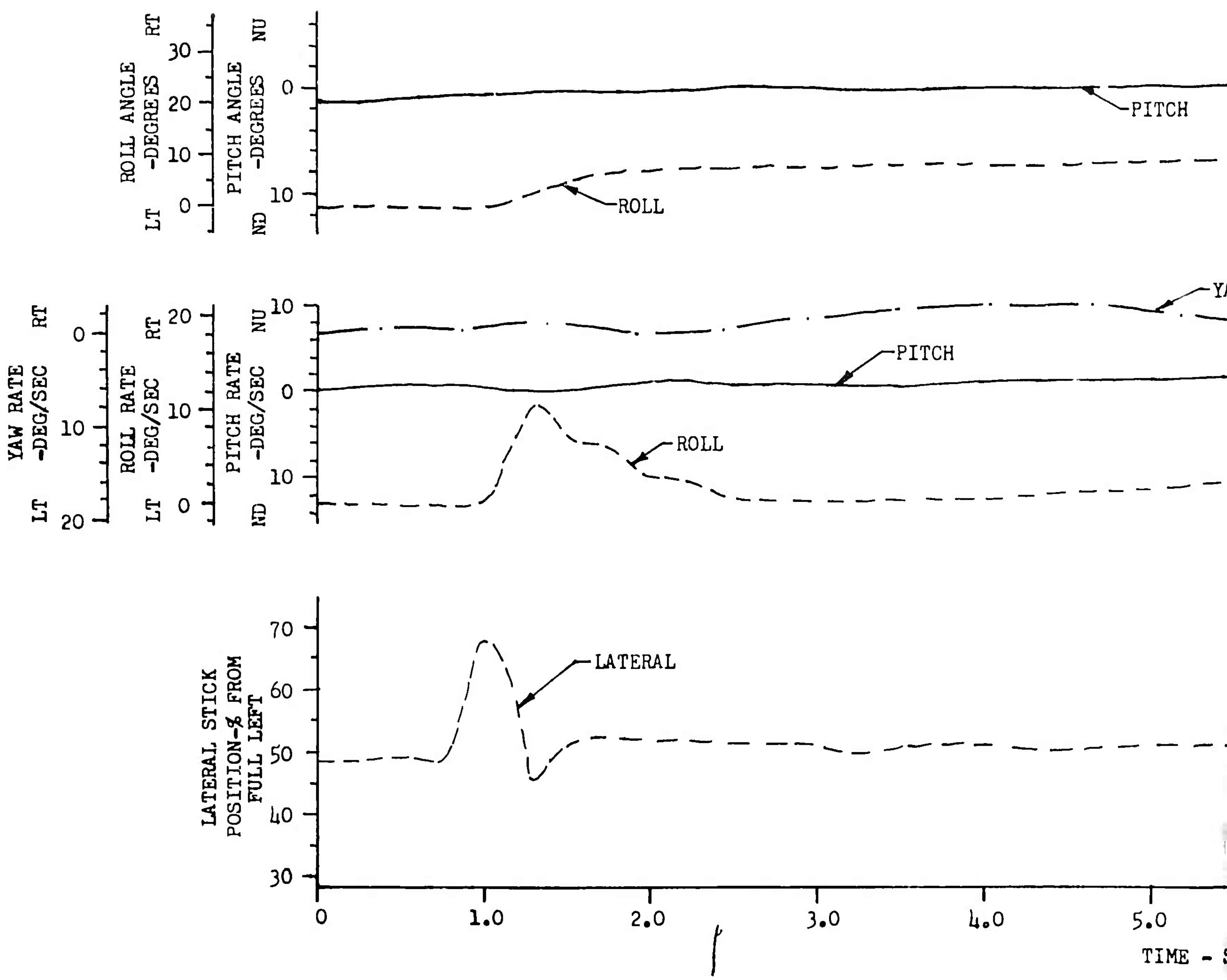


2

FIGURE NO. 34
RIGHT LATERAL PULSE
UH-1G/XM-30 S/N 64-14102
FLIGHT CONDITION: Level Flight
FULL LATERAL TRAVEL: 12.6 IN.

TRI
DENS
GROS
ROT
C.G.

XM-30 IN STOWED POSITION



TRIM AIRSPEED: 91.0 KCAS
DENSITY ALTITUDE: 5530 FT.
GROSS WEIGHT: 8410 LB.
ROTOR SPEED: 324 RPM
C.G. LOCATION: STA 134.0 (aft)

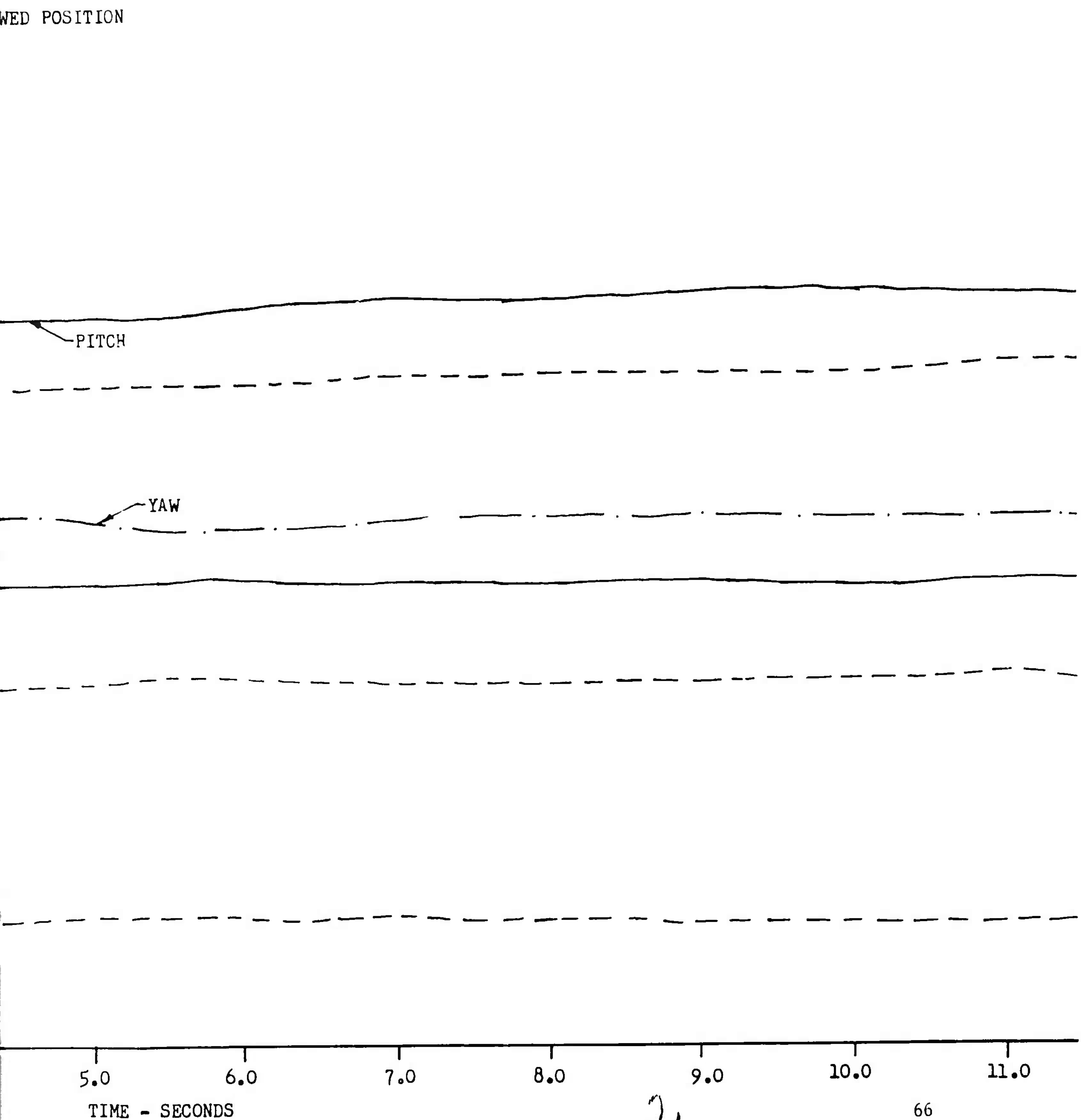
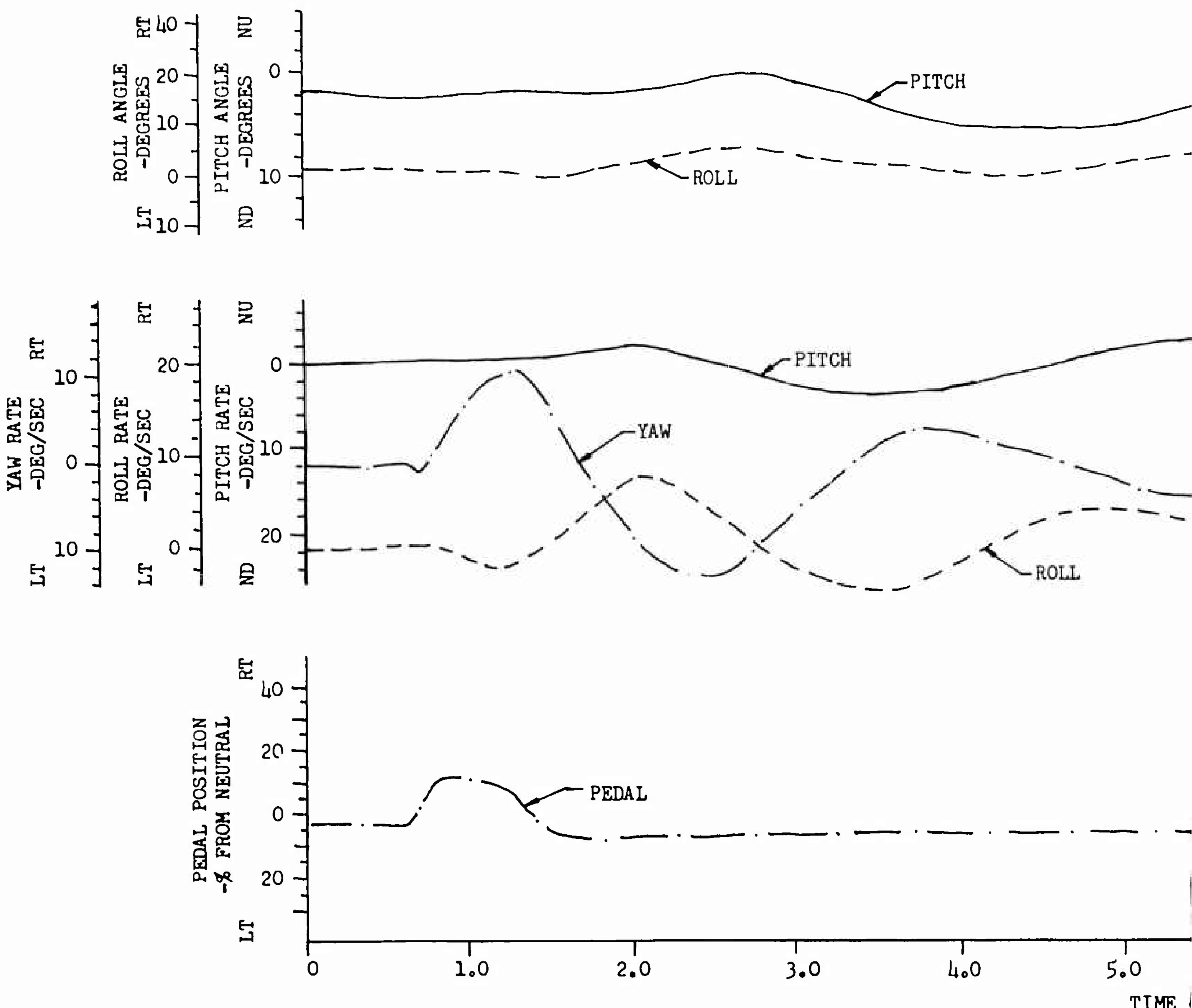
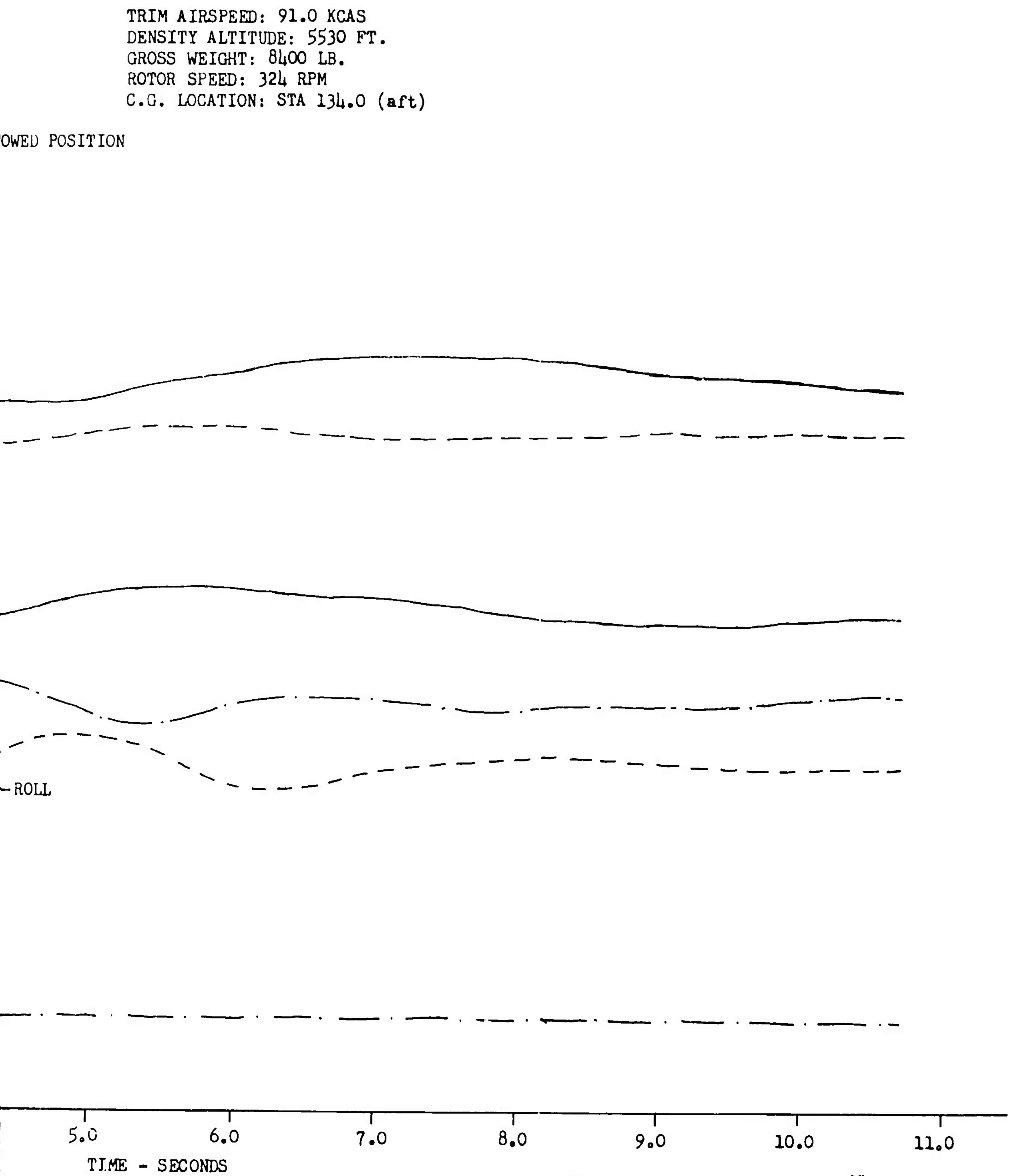


FIGURE NO. 35
RIGHT PEDAL PULSE
UH-1C/XM-30 S/N 64-14102
FLIGHT CONDITION: Level Flight
FULL PEDAL TRAVEL: 6.6 IN.

TRI
DEN
GRO
ROT
C.C

XM-30 IN STOWED POSITION

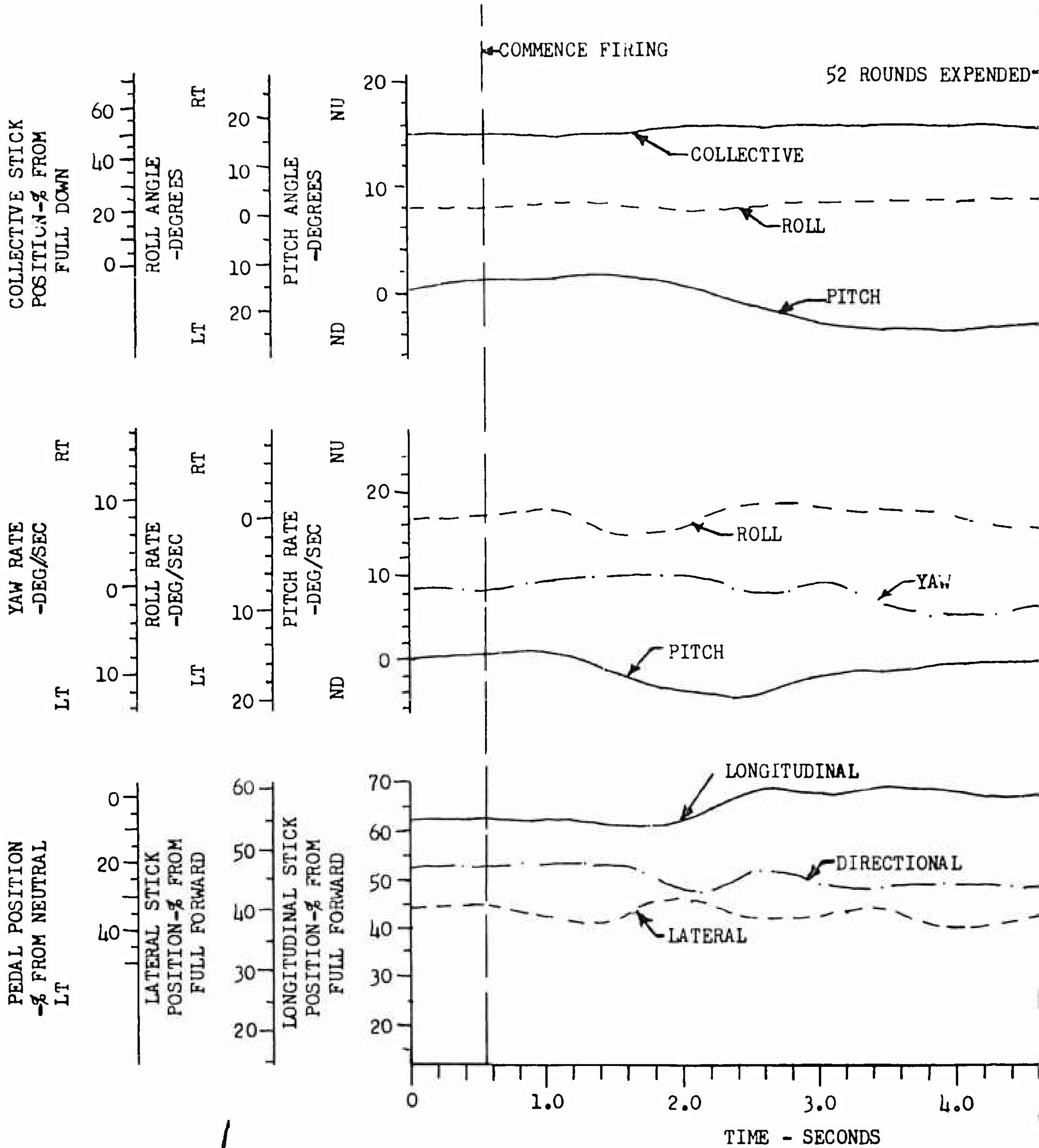



TRIM AIRSPEED: 91.0 KCAS
DENSITY ALTITUDE: 5530 FT.
GROSS WEIGHT: 8400 LB.
ROTOR SPEED: 324 RPM
C.G. LOCATION: STA 134.0 (aft)
OWED POSITION
ROLL
5.0
6.0
7.0
8.0
9.0
10.0
11.0
TIME - SECONDS

2

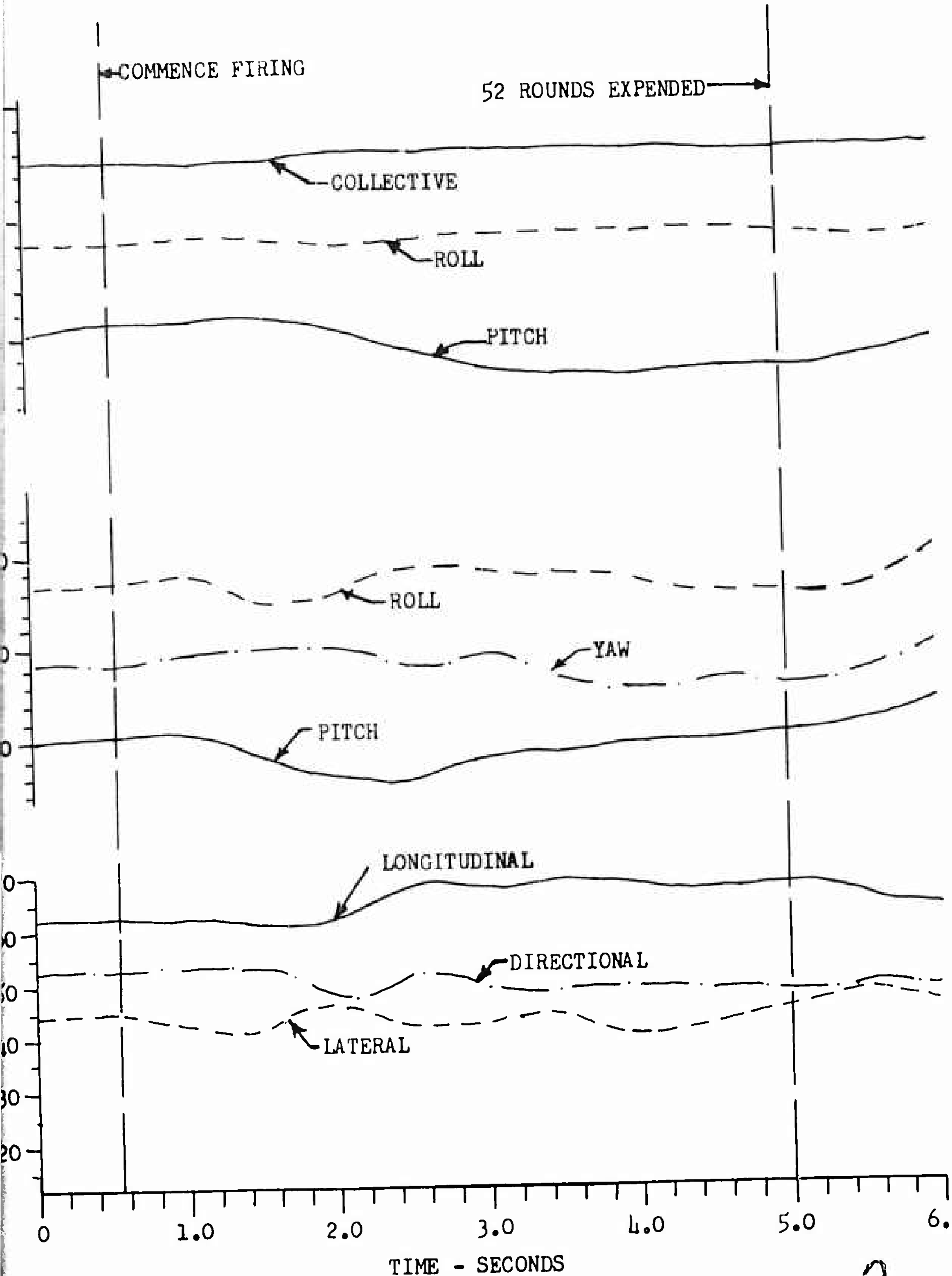
FIGURE NO. 42
TIME HISTORY OF WEAPONS FIRING
UH-1C/XM-30 S/N 64-14102
FLIGHT CONDITION: Hover (IGE)
CONFIGURATION: Both guns elevated, both guns firing.

TRIM AIRSPEED: 0 KCAS
DENSITY ALTITUDE: 4970 FT.
GROSS WEIGHT: 8200 LB.
ROTOR SPEED: 324 RPM
C.G. LOCATION: STA 128.1 (fwd



42
PONS FIRING
64-14102
Hover (IGE)
h guns elevated,
h guns firing.

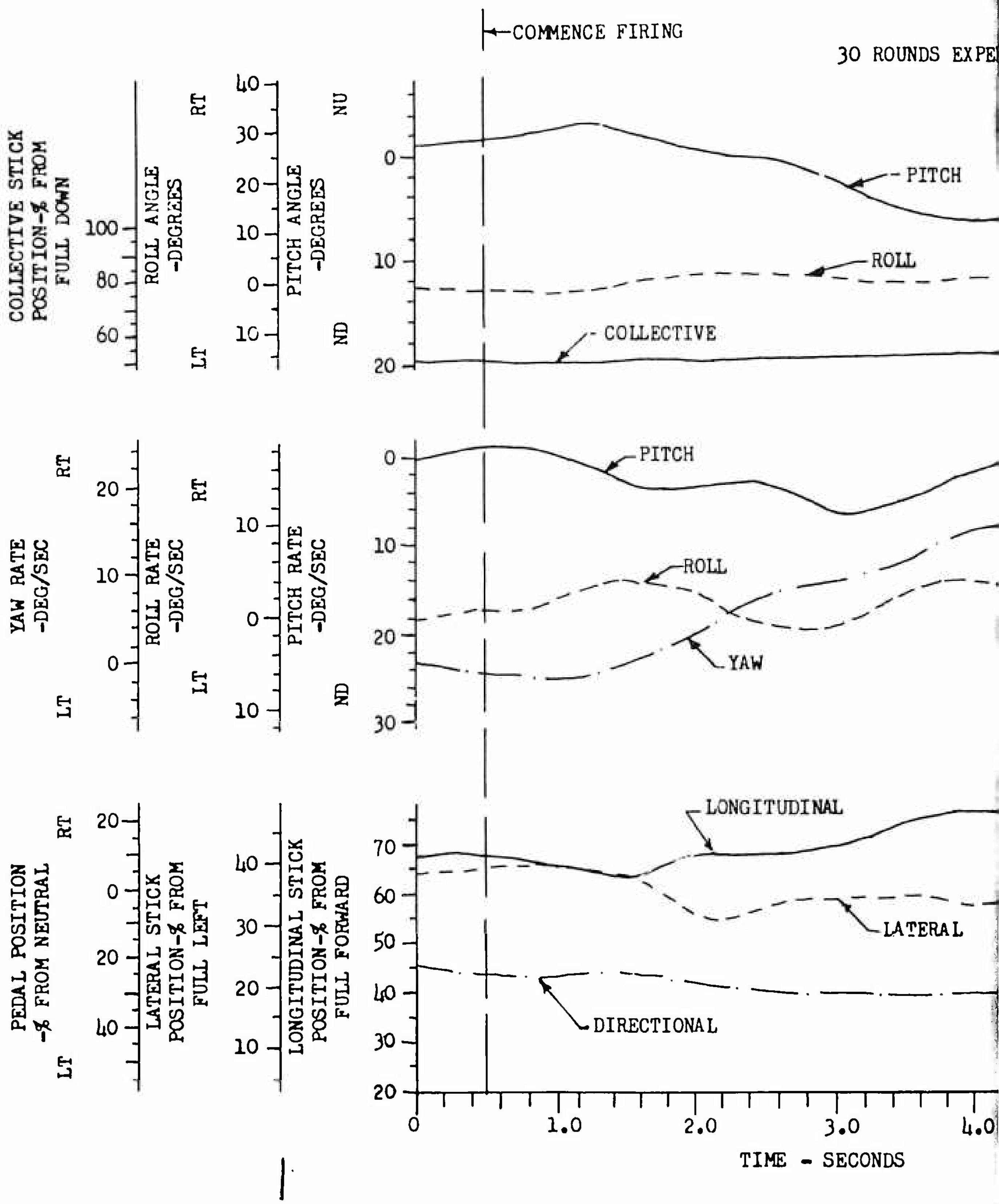
TRIM AIRSPEED: 0 KCAS
DENSITY ALTITUDE: 4970 FT.
GROSS WEIGHT: 8200 LB.
ROTOR SPEED: 324 RPM
C.G. LOCATION: STA 128.1 (fwd)



2

FIGURE NO. 43
TIME HISTORY OF WEAPONS FIRING
UH-1C/XM-30 S/N 64-14102
FLIGHT CONDITION: Hover (IGE)
CONFIGURATION: Both guns elevated and traversed right, right gun firing.

TRIM AIRSPEED: 0 KCAS
DENSITY ALTITUDE: 5080 F
GROSS WEIGHT: 7810 LB.
ROTOR SPEED: 324 RPM
C.G. LOCATION: STA 128.1



E NO. 43
OF WEAPONS FIRING
0 S/N 64-14102
ION: Hover (IGE)
: Both guns elevated and
ed right, right gun firing.

TRIM AIRSPEED: 0 KCAS
DENSITY ALTITUDE: 5080 FT.
GROSS WEIGHT: 7810 LB.
ROTOR SPEED: 324 RPM
C.G. LOCATION: STA 128.1 (fwd)

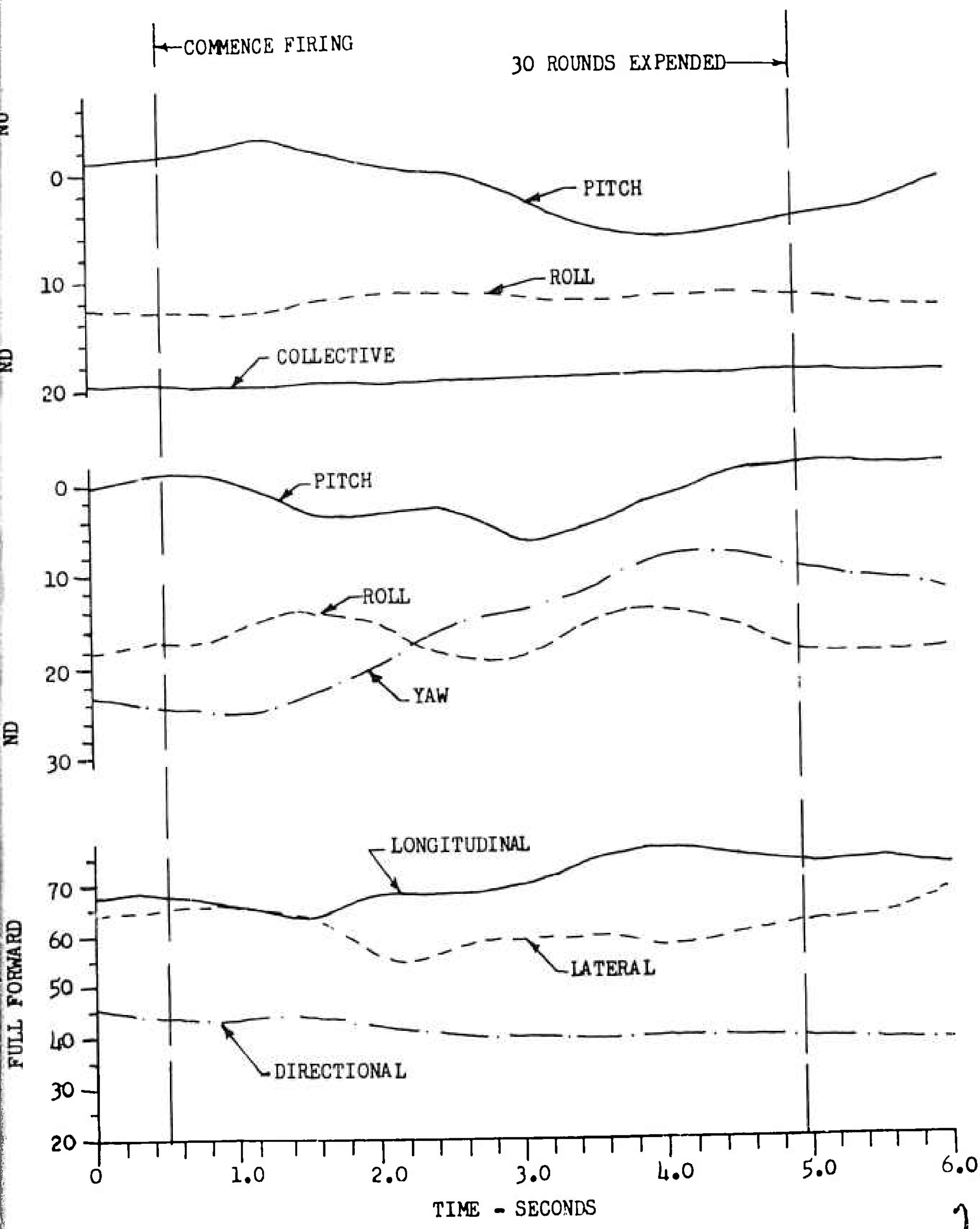
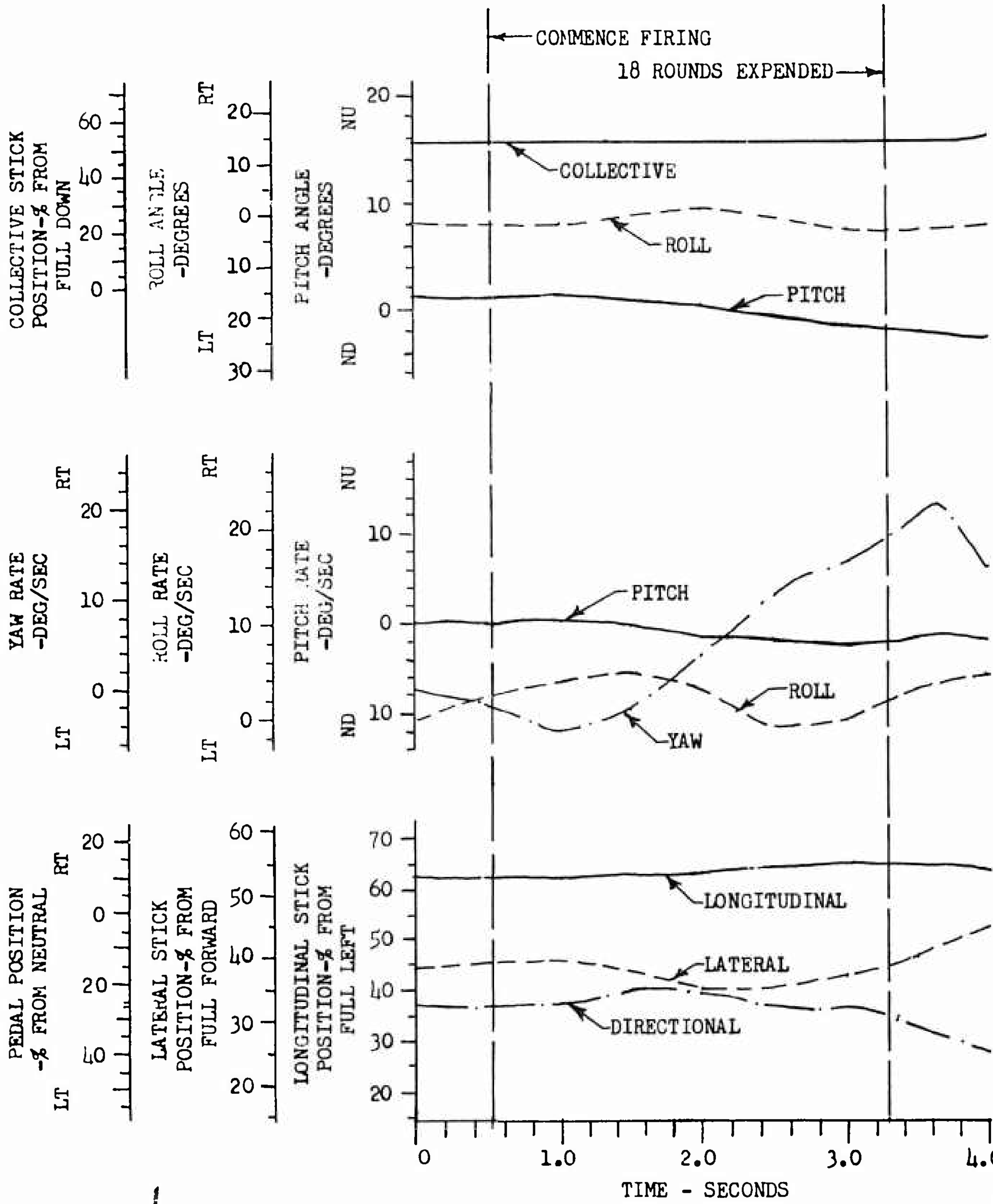


FIGURE NO. 44
TIME HISTORY OF WEAPONS FIRING
UH-1C/XM-30 S/N 64-14102
FLIGHT CONDITION: Hover (IGE)
CONFIGURATION: Both guns stowed, right gun firing.

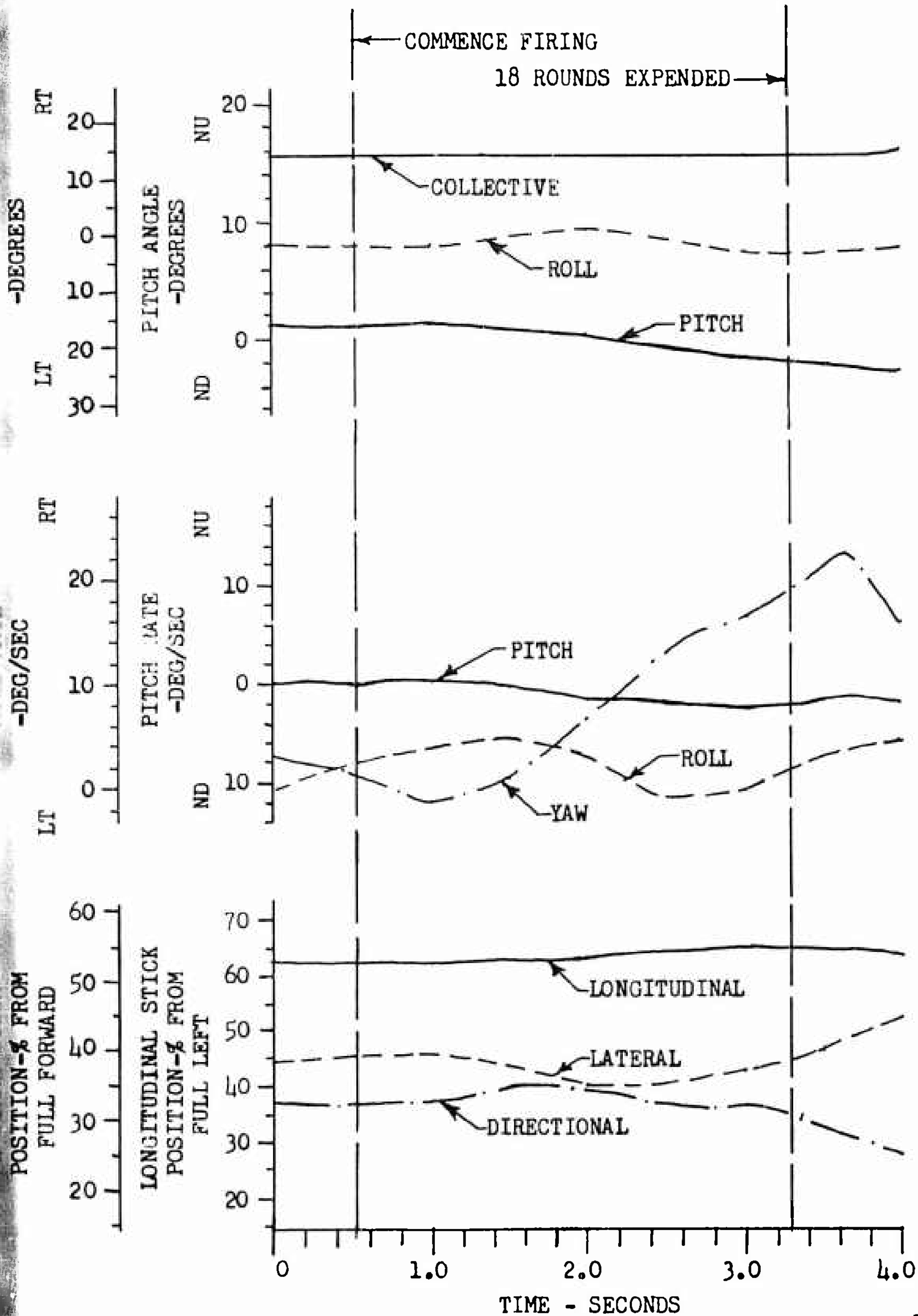
TRIM AIRSPEED: 0 KCAS
DENSITY ALTITUDE: 5080 FT.
GROSS WEIGHT: 7950 LB.
ROTOR SPEED: 324 RPM
C.G. LOCATION: STA 128.1 (fwd)



2

FIGURE NO. 44
HISTORY OF WEAPONS FIRING
H-1C/XM-30 S/N 64-14102
HT CONDITION: Hover (IGE)
IGURATION: Both guns stowed,
right gun firing.

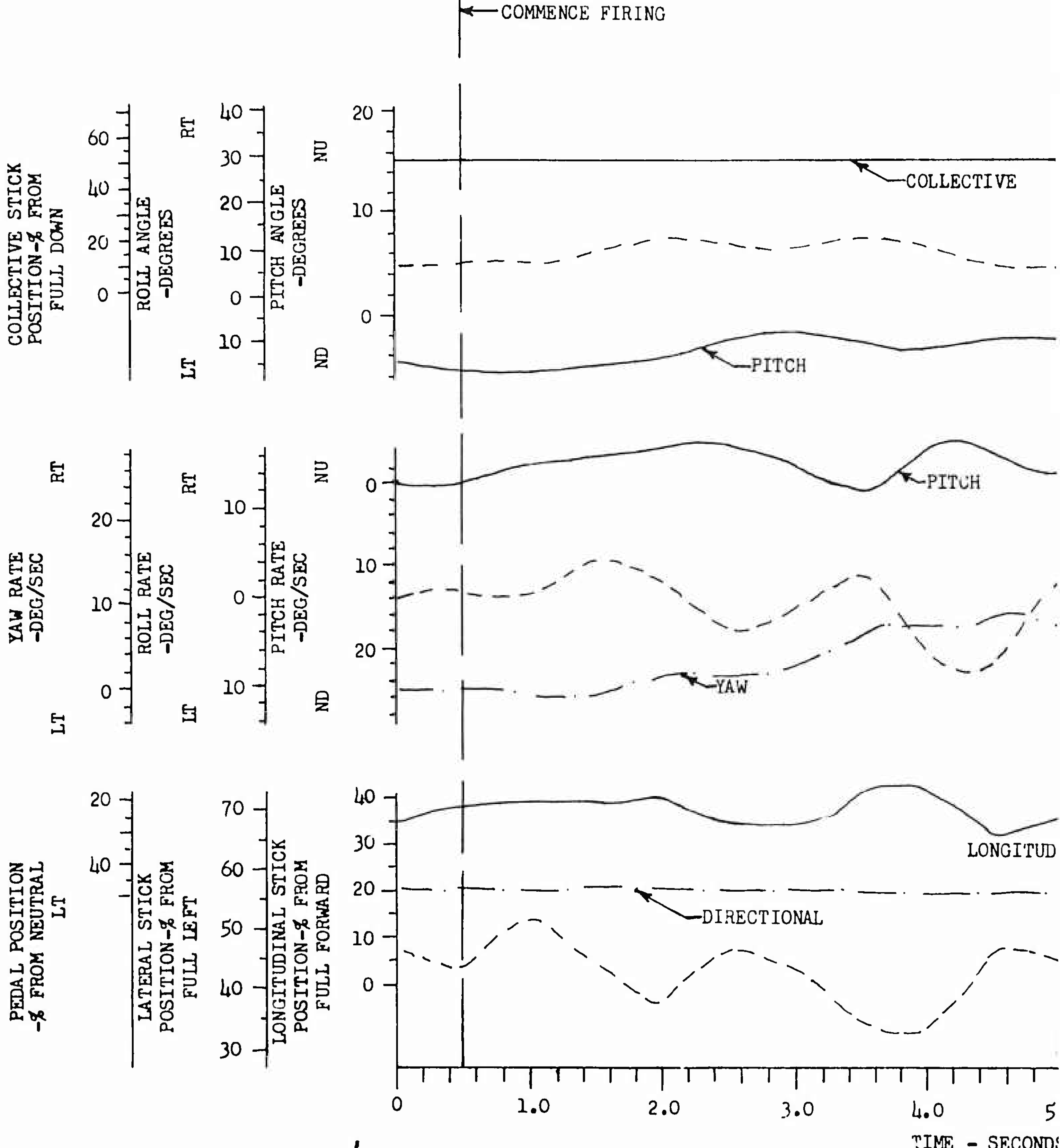
TRIM AIRSPEED: 0 KCAS
DENSITY ALTITUDE: 5080 FT.
GROSS WEIGHT: 7950 LB.
ROTOR SPEED: 324 RPM
C.G. LOCATION: STA 128.1 (fwd)



2

FIGURE NO. 45
TIME HISTORY OF WEAPONS FIRING
UH-1C/XM-30 S/N 64-14102
FLIGHT CONDITION: Right Sideward Flight
CONFIGURATION: Both guns elevated and traversed right, right gun firing.

TRIM AIRSPEED:
DENSITY ALTITU
GROSS WEIGHT:
ROTOR SPEED:
C.G. LOCATION:



RING
2
ideward Flight
elevated and
ht gun firing.

FIRING

TRIM AIRSPEED: 30 KCAS (estimated)
DENSITY ALTITUDE: 4860 FT.
GROSS WEIGHT: 8200 LB.
ROTOR SPEED: 324 RPM
C.G. LOCATION: STA 128.1 (fwd)

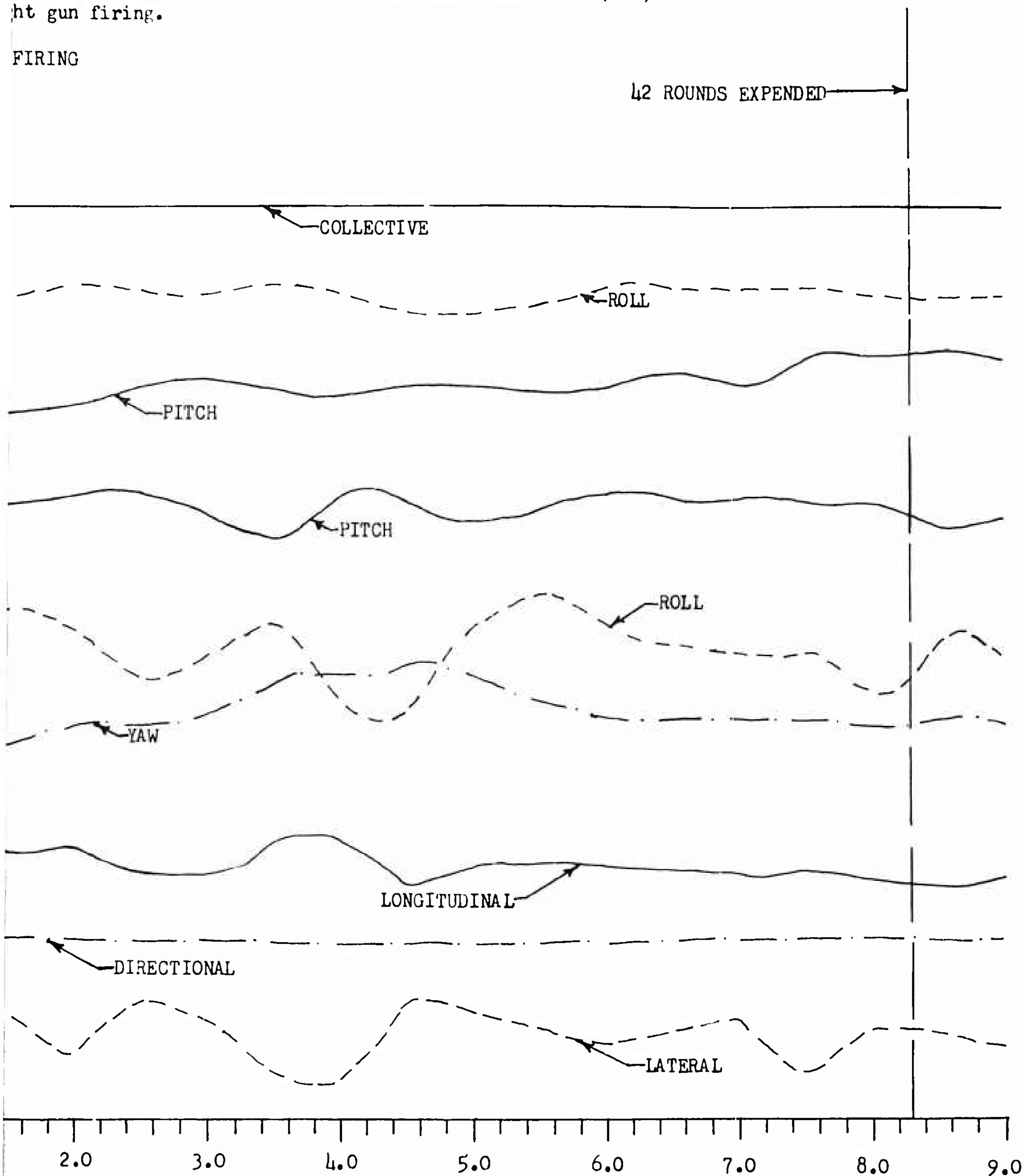
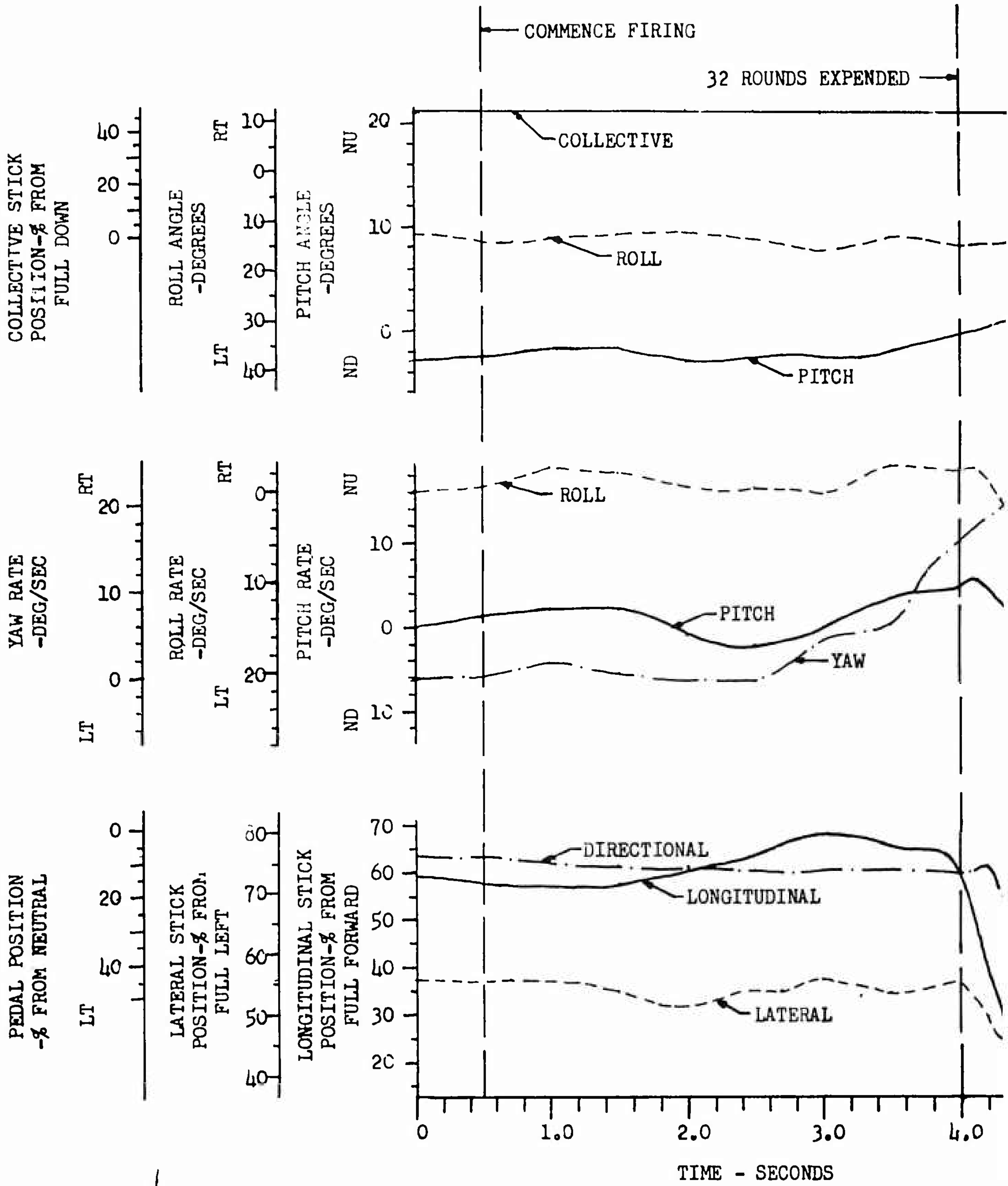


FIGURE NO. 46
TIME HISTORY OF WEAPONS FIRING
UH-1C/XM-30 S/N 64-14102
FLIGHT CONDITION: Rearward Flight
CONFIGURATION: Both guns elevated, both guns firing.

TRIM AIRSPEED: 40 KCAS (esti
DENSITY ALTITUDE: 4850 FT.
GROSS WEIGHT: 7990 LB.
ROTOR SPEED: 324 RPM
C.G. LOCATION: STA 128.1 (fwd



JRE NO. 46
Y OF WEAPONS FIRING
30 S/N 64-14102
ITION: Rearward Flight
ON: Both guns elevated,
both guns firing.

TRIM AIRSPEED: 40 KCAS (estimated)
DENSITY ALTITUDE: 4850 FT.
GROSS WEIGHT: 7990 LB.
ROTOR SPEED: 324 RPM
C.G. LOCATION: STA 128.1 (fwd)

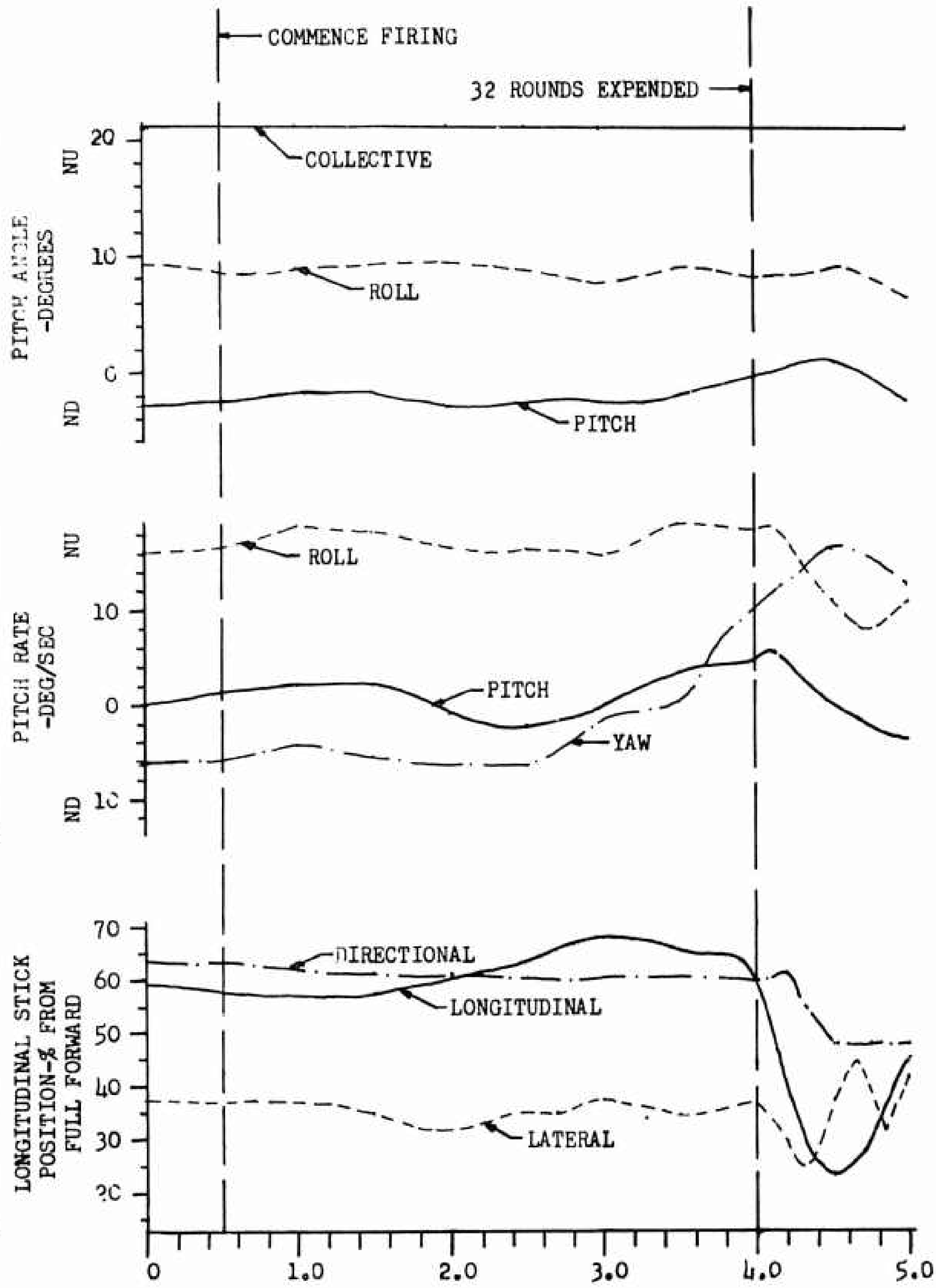
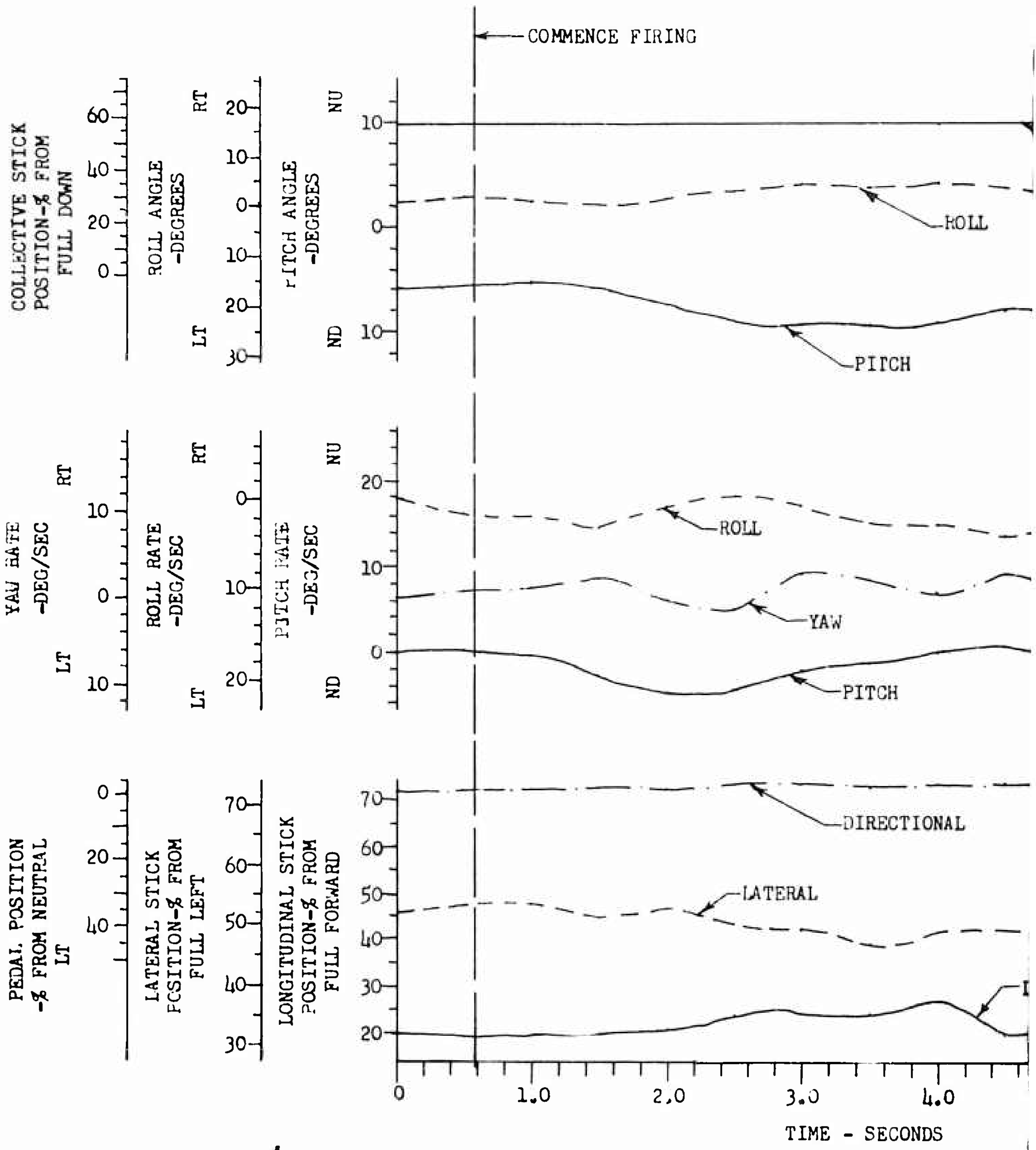


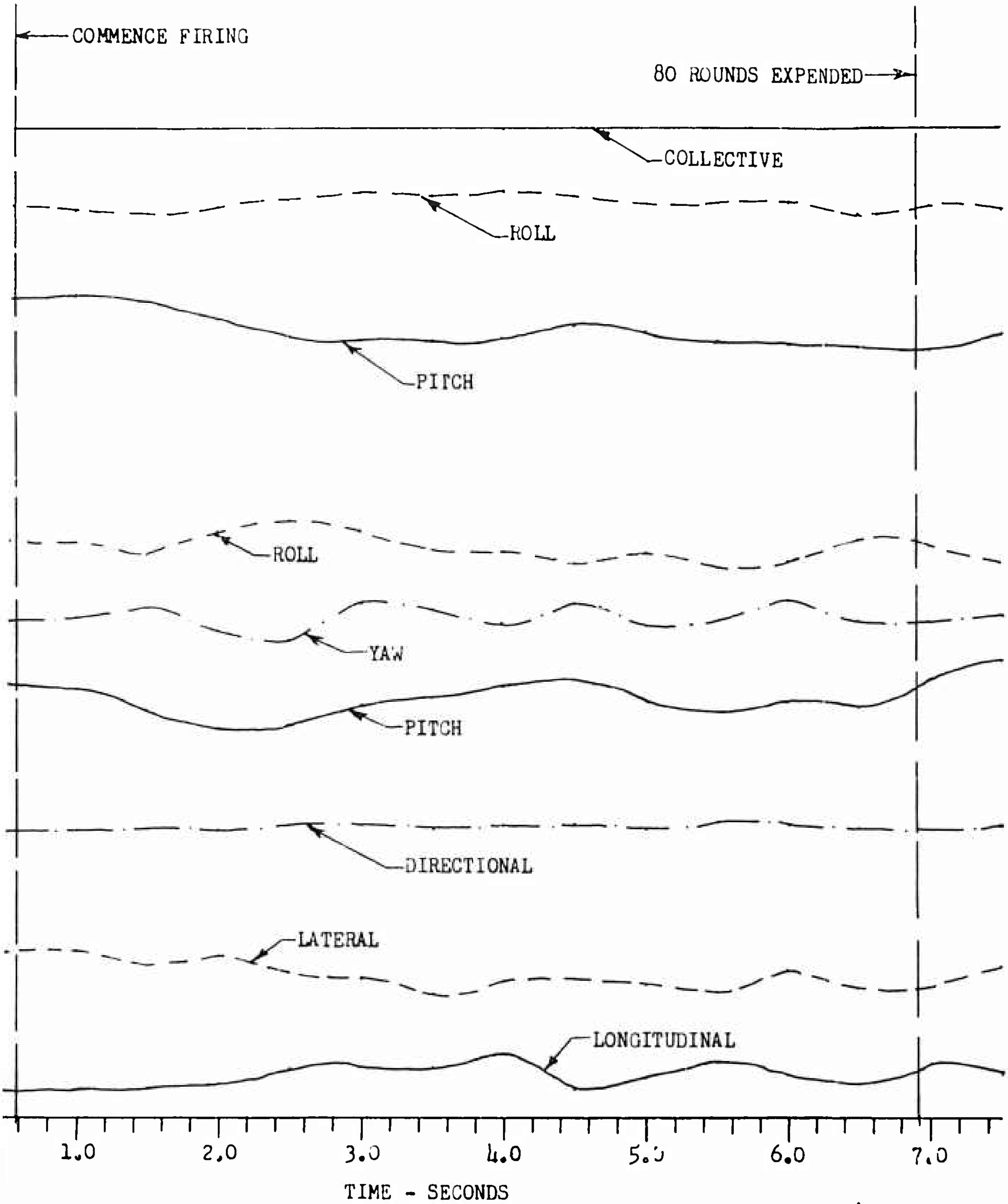
FIGURE NO. 47
TIME HISTORY OF WEAPONS FIRING
UH-1C/XM-30 S/N 64-14102
FLIGHT CONDITION: Dive at V_{ne}
CONFIGURATION: Both guns stowed, both guns firing.

TRIM AIRSPEED: 131 KCAS
DENSITY ALTITUDE: 6350 F
GROSS WEIGHT: 7970 LB.
ROTOR SPEED: 324 RPM
C.G. LOCATION: STA 128.1



¦7
?ONS FIRING
54-14102
ive at V_{ne}
guns stowed,
guns firing.

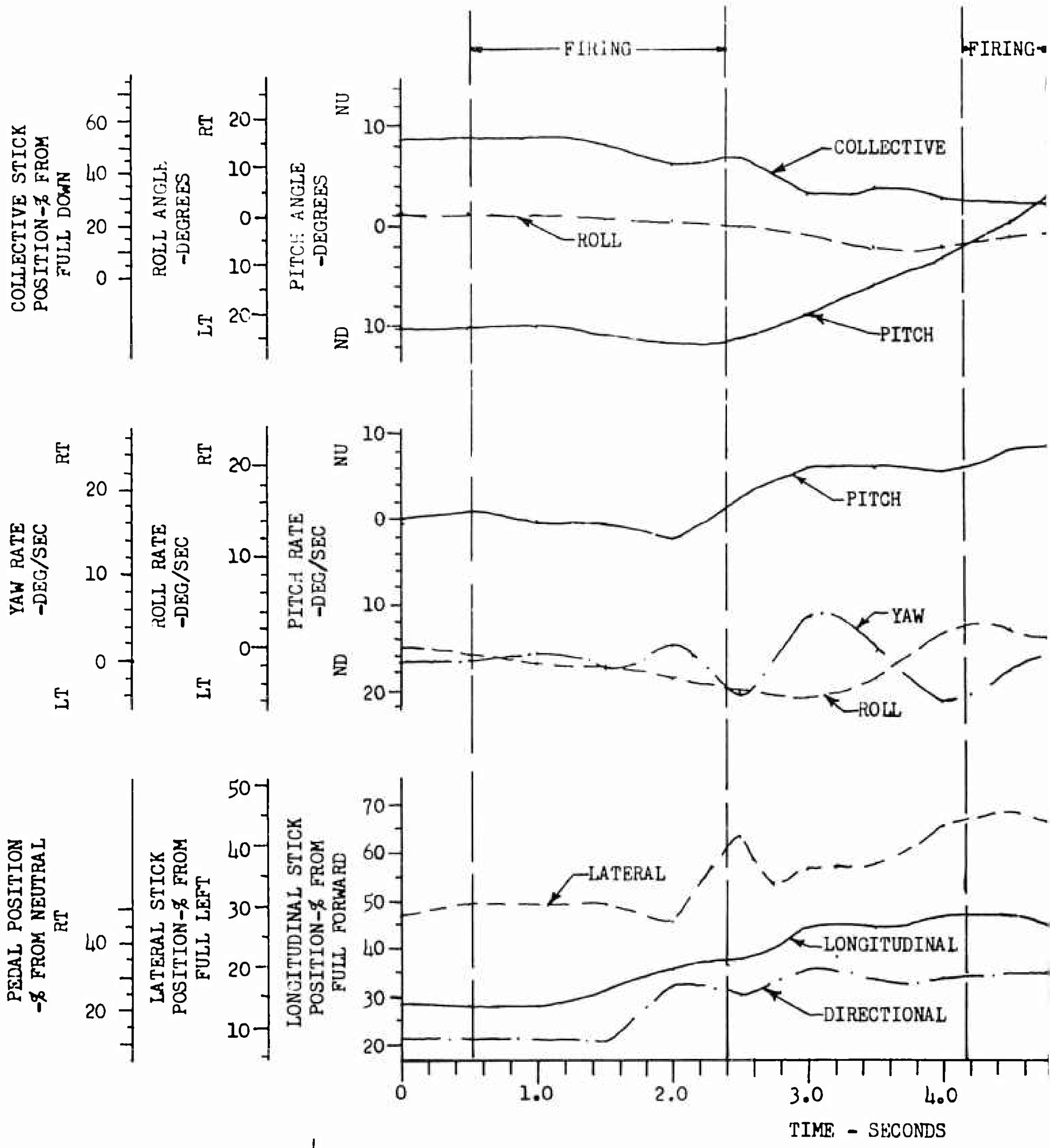
TRIM AIRSPEED: 131 KCAS
DENSITY ALTITUDE: 6350 FT.
GROSS WEIGHT: 7970 LB.
ROTOR SPEED: 324 RPM
C.G. LOCATION: STA 128.1 (fwd)



2

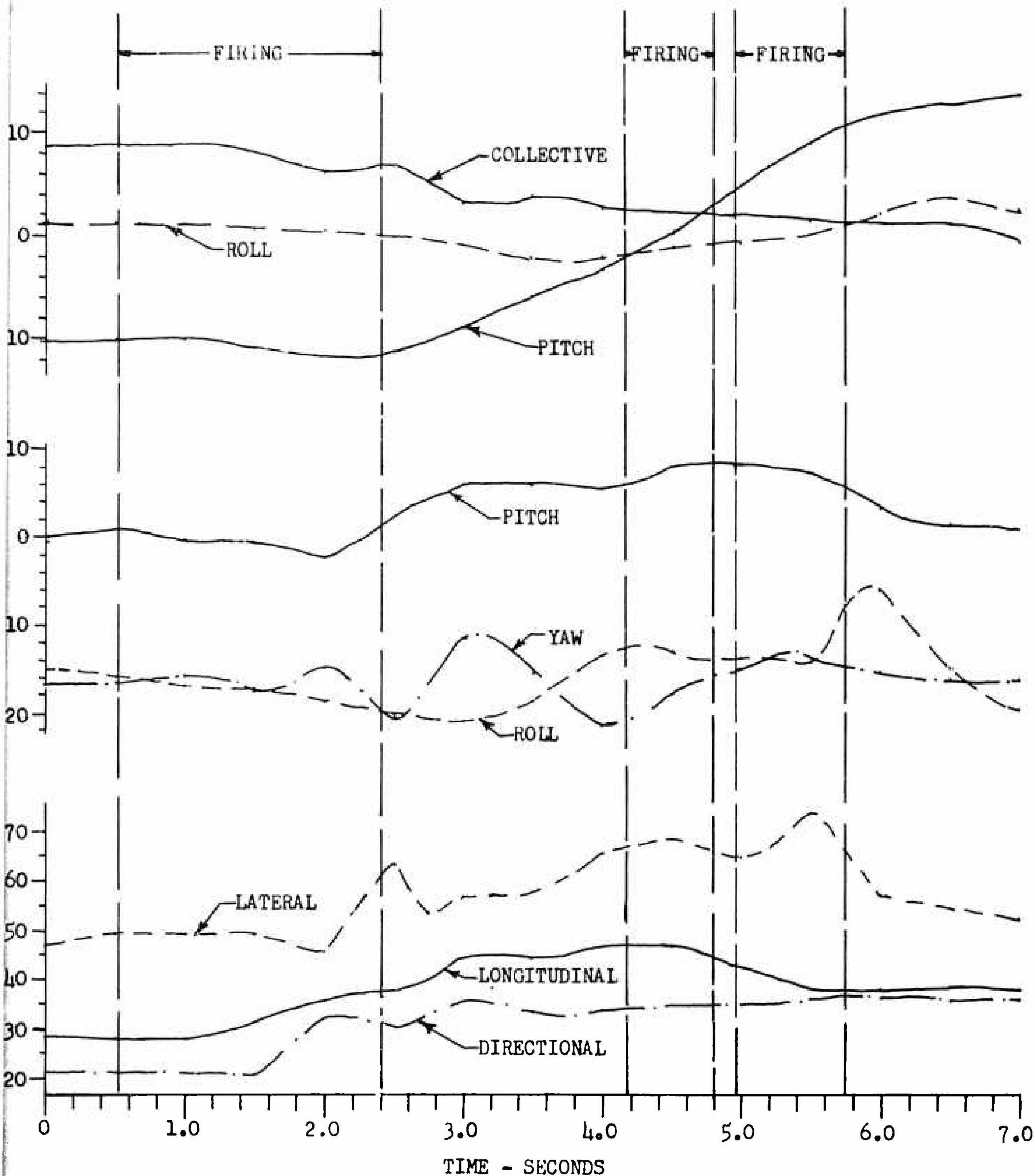
FIGURE NO. 48
TIME HISTORY OF WEAPONS FIRING
UH-1C/XM-30 S/N 64-14102
FLIGHT CONDITION: Throttle Chop at V_{ne}
CONFIGURATION: Both guns depressed, both guns firing.

TRIM AIRSPEED: 126 KC
DENSITY ALTITUDE: 484
GROSS WEIGHT: 8130 LB
ROTOR SPEED: 324 RPM
C.G. LOCATION: STA 12
TOTAL ROUNDS EXPENDED



IGURE NO. 48
DRY OF WEAPONS FIRING
XM-30 S/N 64-14102
NDITION: Throttle Chop at V_{ne}
TION: Both guns depressed,
both guns firing.

TRIM AIRSPEED: 126 KCAS
DENSITY ALTITUDE: 4840 FT.
GROSS WEIGHT: 8130 LB.
ROTOR SPEED: 324 RPM
C.G. LOCATION: STA 128.1 (fwd)
TOTAL ROUNDS EXPENDED: 30



APPENDIX II

REFERENCES

a. Letter, Test Directive, AMSAV-EF, USAAVCOM, 6 June 1967, subject: "Flight Testing and Support of the Airworthiness Qualification of the UH-1C Equipped with XM-30 Weapon System", with revision dated 23 June 1967.

b. Letter, SAVTE-F, USAAVNTA, 19 July 1967, subject: "Contractor Compliance with Flight Test Specification Requirements for the UH-1C/XM-30 Weapon System."

c. Letter, AMSAV-EF, USAAVCOM, undated, subject: "Safety of Flight Release for UH-1C/XM-30 Weapon System."

d. Technical Manual TM 55-1520-211-10, "Operator's Manual, Army Models UH-1A and UH-1B Helicopters," with 1 changes through 5 June 1967, Hq, Department of the Army, 28 December 1965.

e. Report, Phase D, "Engineering Flight Test of the UH-1B Helicopter Equipped with the Model 540 Rotor System," USAAVNTA, December 1966.

f. Report No. 204-100-147, "Preliminary Flight Test Evaluation of XM-30 Armament Sub-system During Non-firing and Firing Flight," Volumes I and II, Bell Helicopter Company, February 11, 1967.

g. Letter, Test Plan, SAVTE-F, USAAVNTA, 11 July 1967, subject: "Army Preliminary Evaluation of the UH-1C Equipped with the XM-30 Weapon System."

h. Report No. 204-947-196, "Specification for the Qualification Flight Testing of the XM-30 Weapon System Installed on a UH-1B Helicopter Equipped with a 540 Rotor System," Bell Helicopter Company, November 15, 1965.

i. Letter, AMSWE-RDW, USAWECOM, 28 November 1966, subject: "30 mm, XM30/XM140 Program."

j. Training Manual, "30 mm Helicopter Armament Subsystem, XM30," General Electric, Missile and Armament Department.

APPENDIX III

DESCRIPTION OF WEAPON SYSTEM

XM-30

The XM-30 Helicopter Weapon System consists of the UH-1C helicopter, the dual installation of the XM-140, 30 mm automatic gun, side-mounted in electrically powered turrets, the ammunition feed system, sighting station, and electrical components to include a turret control panel (photo 5). Total weight of the system, less ammunition, is estimated as 962 lb. Table 5 contains applicable weights and dimensions of components. Additional details and photographs may be found in references f and j.

XM-140 Automatic Gun

The 30 millimeter automatic gun is an air-cooled, externally powered weapon with a design rate of fire of 425 ± 25 spm. Recoil forces vary with sear adjustment; however, a design criterion of 1500 to 2000 lb per gun has been used for load prediction.

Turret Assembly

A turret assembly is mounted on four hard points on each side of the helicopter. Design travel is 60 degrees outboard and 5 degrees inboard azimuth with an elevation capability of +8 degrees and -45 degrees. Electrical and mechanical stops prevent the guns from firing at or beyond the limits of travel. Both guns will fire simultaneously only within ±5 degrees in azimuth. The turret assembly is equipped with forward and aft removable fairings designed to reduce aerodynamic drag.

Ammunition Feed System

The ammunition feed system provides storage for 1200 rounds of 30 mm ammunition located in two 600 round ammunition boxes mounted across the aft cabin of the UH-1C helicopter. Ammunition booster assemblies lift the ammunition from the boxes to the flexible chutes leading to the gun. A redesigned link ejection chute was added to the system to avoid link damage to helicopter components including the elevator and tail rotor.

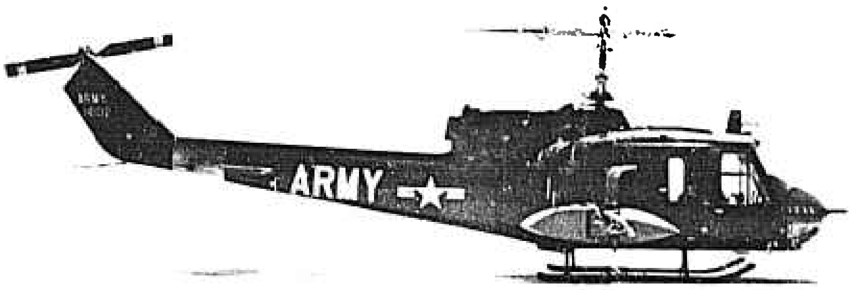


Photo 5 - UH-1C/XM-30

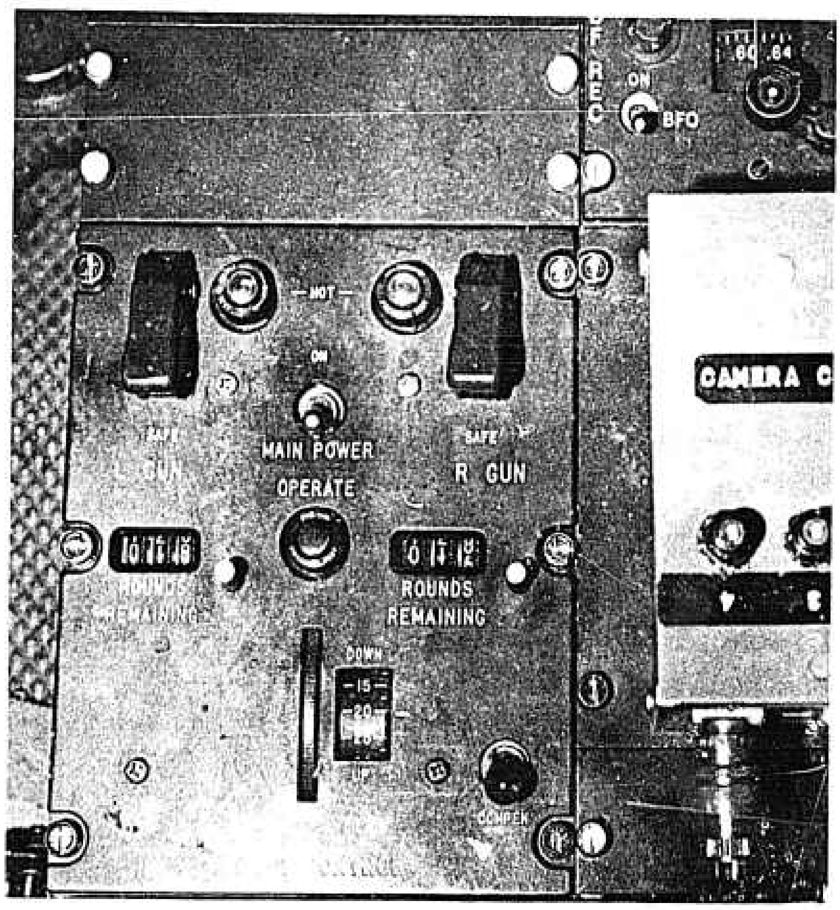


Photo 6 - Turret Control Panel

Sighting and Firing Systems

The hand control sight provides for aiming and firing the guns by the copilot/gunner. It allows full traverse and elevation of the guns by the copilot and is secured overhead when not in use. With the sight stowed, the guns may be fired in the forward position (0 degrees azimuth) by the pilot or copilot using triggers on the cyclic sticks. Elevation may be manually controlled using the adjustment provided on the turret control panel.

Turret Control Panel

The turret control panel is mounted in the cockpit on the lower pedestal console and is accessible to the copilot or pilot. It contains the main power switch, right and left gun arming switches, rounds remaining counters for each gun, and the manually operated elevation control mentioned in the preceding paragraph (see photo 6).

Table 5. XM-30 Component Data (Note 1).

Component	Weight lb	Length in.	Height in.	Width in.
XM 140 Gun (2)	330	47.5 (Seared) 56.5 (Off sear)	17.5	14.5
Turret Assembly (2)	363	37.0	20.0	36.0
Fairings Forward Aft		 32.8 30.5	 20.5 (2) 18.0	 37.5
Ammunition Box (2)	135	63.0	32.0	10.5
Ammunition Boosters (2)	36	36.5	9.0	10.2
Sight	14	20.3 (Stowed) 28.1 (Extended)	7.0	15.7
Remaining XM-30 Kit Components	84			

Note (1): Additional weight of 105 lb for airframe modifications, armament group supports, and electrical provisions.

Note (2): Maximum diameter.

APPENDIX IV

TEST INSTRUMENTATION

The test instrumentation for the APE was installed, calibrated, and maintained by contractor personnel. The installation consisted of visual instruments in the cockpit and oscillographs mounted in the cargo compartment (photo 7, 8 and 9). The cockpit instrumentation parameters are listed below:

Standard Airspeed System (mph and kt)*
Altitude*
Rotor Speed (sensitive)
Engine Torque*
Gas Generator Speed*
Exhaust Gas Temperature*
Fuel Quantity*
Normal Acceleration
Longitudinal Stick Position
Lateral Stick Position
Pedal Position
Collective Stick Position
Gun Elevation
Gun Azimuth (left and right)
Oscillograph Counter Number

*Denotes standard, calibrated instrument

The following parameters/components were instrumented and recorded on seven Consolidated Electrodynamic Corporation, 18 channel oscillographs:

Parameter	Units
Left Turret Azimuth	Degrees
Right Turret Azimuth	Degrees
Right Turret Elevation	Degrees
Right Aft Upper Brace	Pounds
Right Forward Upper Brace	Pounds
Left Forward Upper Brace	Pounds
Left Aft Upper Brace	Pounds
Left Long Turret Brace	Pounds
Right Long Turret Brace	Pounds
Left Short Turret Brace	Pounds
Right Short Turret Brace	Pounds
28 Volt Source	Volts
400 Cycle Source	Volts

Parameter	Units
Trigger Closure	--
Main Rotor and Tail Rotor Azimuth	Degrees
Left Forward Beam Outboard Vertical	In-lb
Left Forward Beam Outboard Horizontal	In-lb
Left Forward Beam Inboard Vertical	In-lb
Left Forward Beam Inboard Horizontal	In-lb
Left Aft Beam Outboard Vertical	In-lb
Left Aft Beam Outboard Horizontal	In-lb
Left Aft Beam Inboard Vertical	In-lb
Left Aft Beam Inboard Horizontal	In-lb
Right Forward Beam Outboard Vertical	In-lb
Right Forward Beam Outboard Horizontal	In-lb
Right Forward Beam Inboard Vertical	In-lb
Right Forward Beam Inboard Horizontal	In-lb
Right Aft Beam Outboard Vertical	In-lb
Right Aft Beam Outboard Horizontal	In-lb
Right Aft Beam Inboard Vertical	In-lb
Right Aft Beam Inboard Horizontal	In-lb
Forward and Aft Cyclic Boost Tube	Pounds
Lateral Cyclic Boost Tube	Pounds
Collective Boost Tube	Pounds
Directional Pedal Position	% Right
Collective Stick Position	% Up
Longitudinal Cyclic Stick Position	% Forward
Lateral Cyclic Stick Position	% Right
Pitch Rate Gyro	Deg/Sec
Roll Rate Gyro	Deg/Sec
Yaw Rate Gyro	Deg/Sec
Pitch Attitude Gyro	Degrees
Roll Attitude Gyro	Degrees
Lift Link	Pounds
Engine Delta Torque	Lb/in^2
Stabilizer Bar Chord	In-lb
Stabilizer Bar Beam	In-lb
Main Rotor Blade Chord	In-lb
Main Rotor Yoke Extension Chord	In-lb
Main Rotor Yoke Chord	In-lb
Main Rotor Yoke Beam	In-lb
Main Rotor Yoke Extension Beam	In-lb
Main Rotor Blade Beam	In-lb
Mast Torque	In-lb
Mast Perpendicular	In-lb
Mast Parallel	In-lb
Drag Brace	Pounds
Pitch Link	Pounds
Forward and Aft Vibration - Fuel Gage	g

Parameter	Units
Forward and Aft Vibration - Airspeed Indicator	g
Vertical Vibration - Floor Sta 62	g
Engine Work Deck - Lateral Vibration	g
Lateral Floor Vibration - Sta 62	g
Vertical Vibration - CG	g
Forward and Aft Engine Displacement	In
Lateral Engine Displacement	In
Vertical Engine Displacement	In
Tail Boom Longeron Stress - Upper	Psi
Tail Boom Longeron Stress - Crown	Psi
Tail Boom Longeron Stress - Lower	Psi
Forward and Aft Vibration - Altimeter	g
Forward and Aft Vibration - Radio Compartment	g
Forward and Aft Vibration Amplifier Rack J-2	g
Vertical Amplifier Rack J-2	g
Tail Rotor Yoke Chord	In-lb
Tail Rotor Yoke Beam	In-lb
Tail Rotor Pitch Link	Pounds
Tail Rotor Blade Chord	In-lb
Tail Rotor Blade Beam	In-lb
Tail Rotor Shaft Torque	In-lb
Left Elevator Beam	In-lb
Left Elevator Chord	In-lb
Left Elevator Torque	In-lb
Right Elevator Beam	In-lb
Right Elevator Chord	In-lb
Right Elevator Torque	In-lb
Elevator Control Tube at Elevator	Pounds
Elevator Control Tube at Swashplate	Pounds
Right Gun Motor Current	Amperes
Left Gun Motor Current	Amperes
Right Gun Motor Voltage	Volts
Left Gun Motor Voltage	Volts
Right Clutch Solenoid Voltage	Volts
Left Clutch Solenoid Voltage	Volts
Right Sear Solenoid Voltage	Volts
Left Sear Solenoid Voltage	Volts
Right Feed Switch Event	--
Left Feed Switch Event	--
Right Receiver Position	Inches
Left Receiver Position	Inches
Right Booster Rate	Rounds/Sec
Left Booster Rate	Rounds/Sec

Parameter	Units
Right Turret Limit Switch	--
Left Turret Limit Switch	--

The oscillographs were controlled by one switch on each cyclic stick with sychronized counter numbers recorded on each unit. Trigger closure, main rotor, and tail rotor azimuth were also used as correlating parameters.

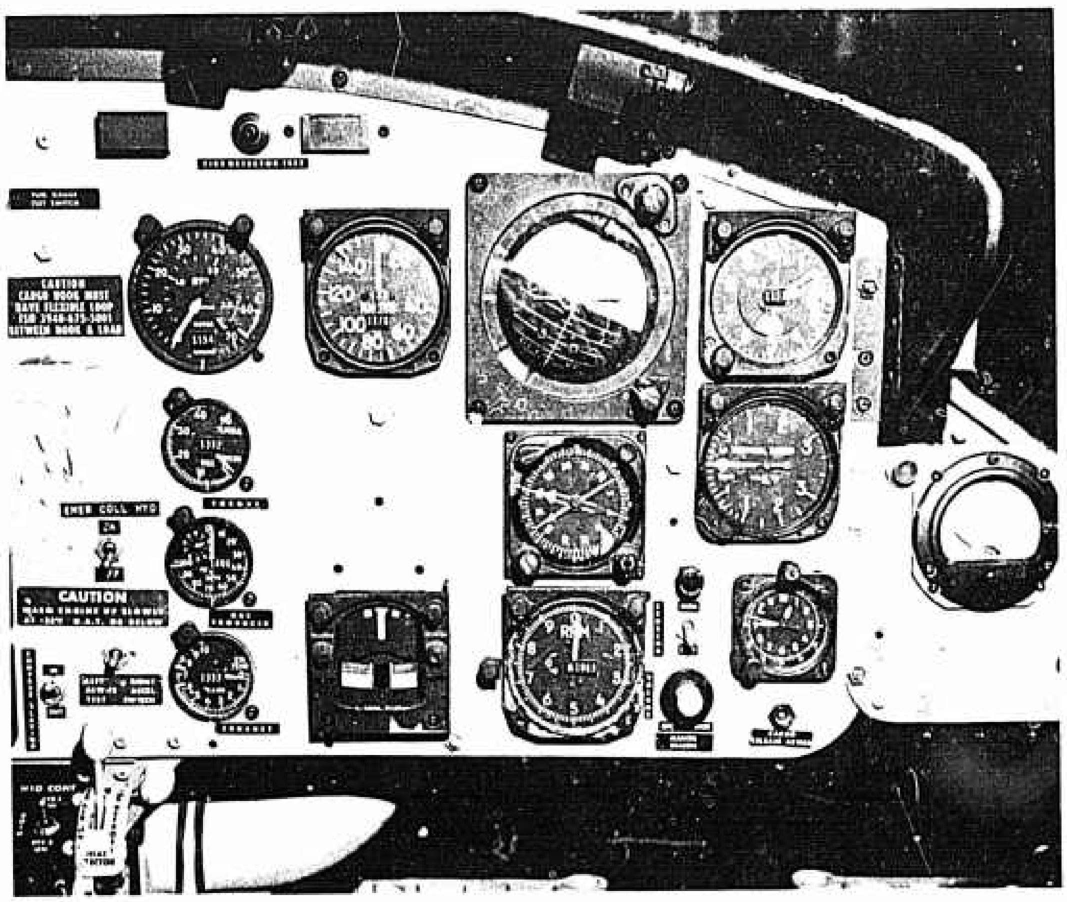


Photo 7 - Pilots Instrument Panel

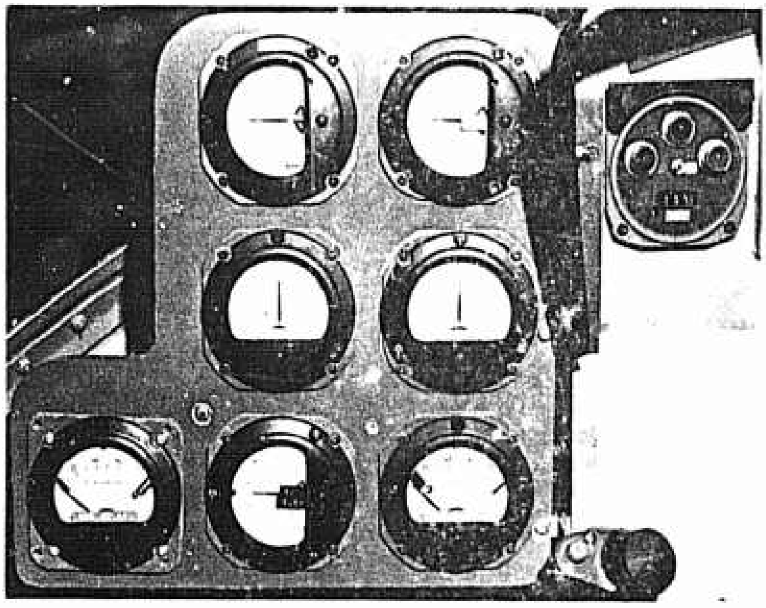


Photo 8 - Control and Turret Position Indicators

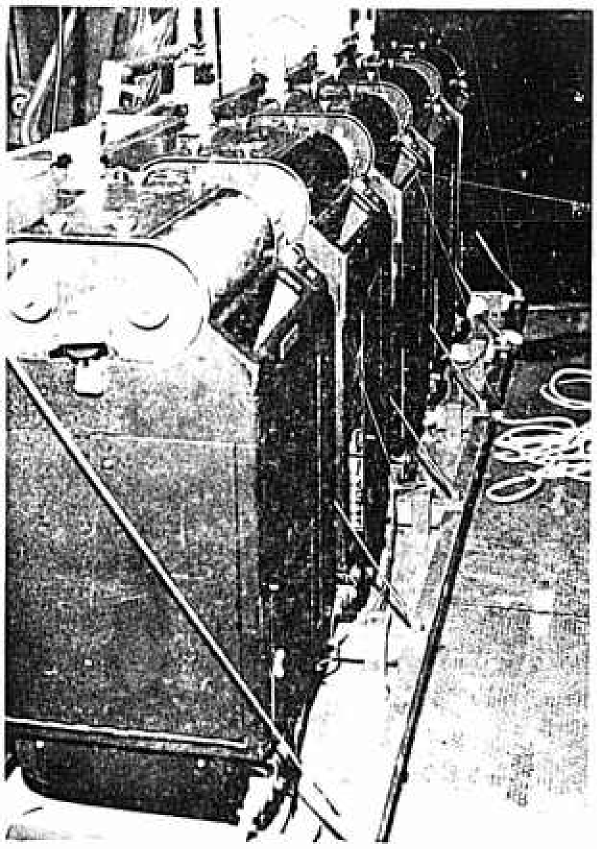


Photo 9
Oscillograph Bank

APPENDIX V

PILOT OPINION RATING INDEX

ADJECTIVE	DESCRIPTION	RATING
EXCELLENT	Includes optimum.	1
VERY GOOD	No unpleasant characteristics; some nuisance type deficiencies where no impairment to normal operation occurs.	2
GOOD	Some unpleasant characteristics in regimes where no impairment to normal operation occurs.	3
FAIR	Some unpleasant characteristics that cause perceptible fatigue; precision tasks possible after additional training.	4
POOR	Controllable but fatiguing; precision tasks possible but difficult even after extensive training.	5
POOR TO BAD	Controllable for short periods only without excessive fatigue; precision tasks questionable even after extensive training.	6
BAD	Total pilot attention required just to operate aircraft; precision tasks impossible.	7
DANGEROUS	Almost uncontrollable; accident probable.	8
CATASTROPHIC	No control; accident certain; escape questionable.	9

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13. ABSTRACT

The Army Preliminary Evaluation of the UH-1C/XM-30 weapon system was conducted by the U. S. Army Aviation Test Activity at Edwards Air Force Base and Fort Irwin, California from 11 July 1967 through 26 July 1967. The degradation in level flight performance attributed to the weapon installation was defined and no objectionable flying qualities were encountered during firing or non-firing tests. The armed mission capability of the helicopter was degraded by high levels of stress, vibration, blast, and noise during firing and restrictive limitations were imposed by gun malfunctions and system gross weight. The reliability of the weapon system was poor and should be improved prior to further Army testing. (U)

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Armed Mission Capability						
Reliability of Weapon System						